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## ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges.

STAR (N-10000 Series)

N83-34885 - N83-37053

IAA (A-10000 Series)

A83-47096 - A83-50211

# AERONAUTICAL ENGINEERING

## A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 169)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in December 1983 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

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# INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 409 reports, journal articles, and other documents originally announced in December 1983 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Six indexes -- subject, personal author, corporate source, contract number, report number, and accession number -- are included.

An annual cumulative index will be published.

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies of accessions are available at \$8.50 per document. Microfiche<sup>(1)</sup> of documents announced in *IAA* are available at the rate of \$4.00 per microfiche on demand. Standing order microfiche are available at the rate of \$1.75 per microfiche for AIAA meeting papers, and \$1.45 per microfiche for *IAA* source documents.

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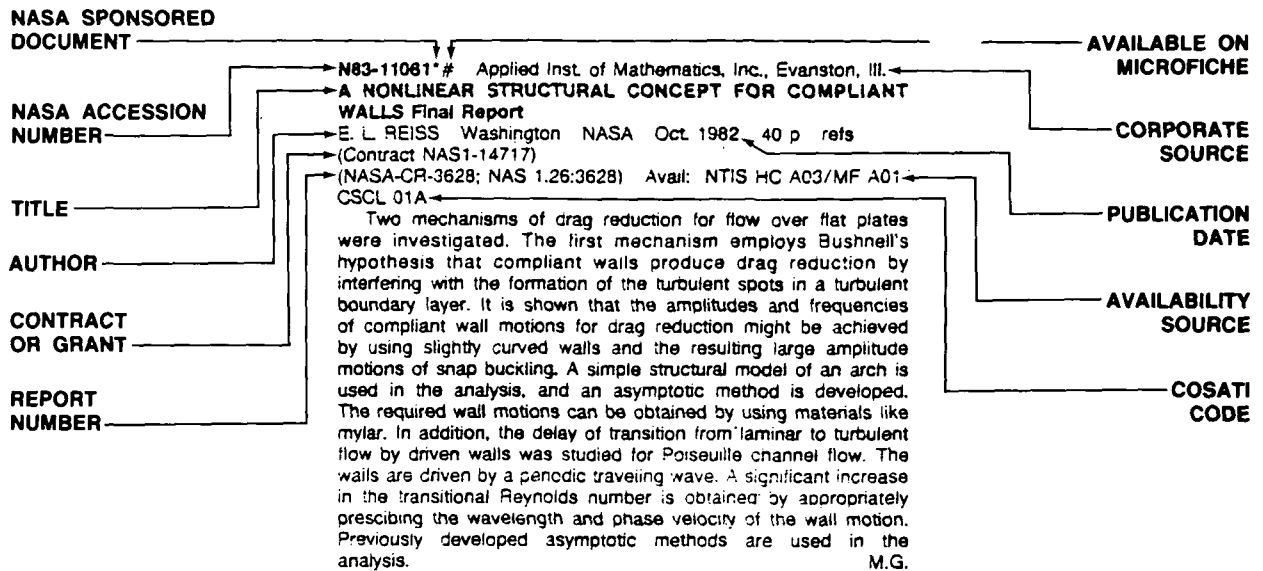
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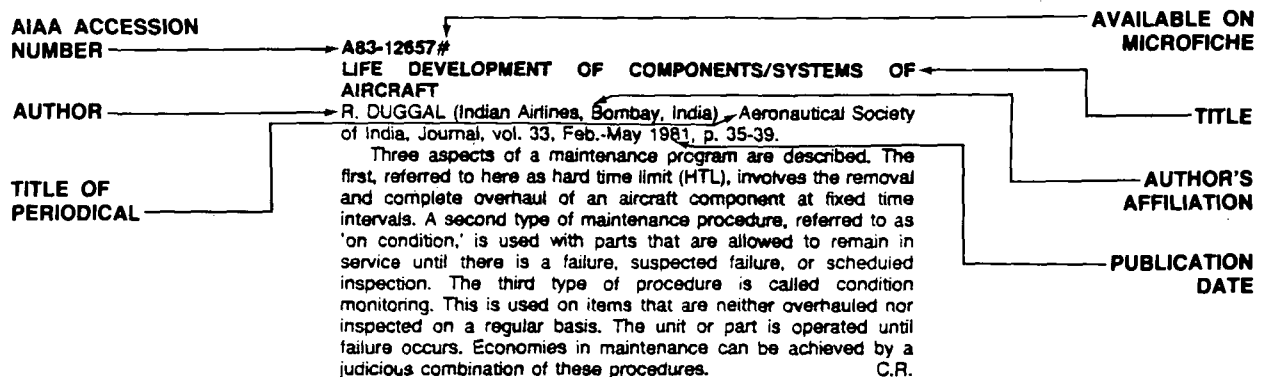


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# AERONAUTICAL ENGINEERING

*A Continuing Bibliography (Suppl. 169)*

JANUARY 1984

01

## AERONAUTICS (GENERAL)

**A83-47182#**

### **AUTOMATED RIVETER FOR SPHERICAL AIRCRAFT CELL STRUCTURES [AUTOMATISCHE NIETANLAGE FUER SPHAERISCH VERFORMTE FLUGZEUGZELLENSTRUKTUREN]**

B. HABERKORN (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 47 p. In German.

In order to reduce the costs of riveting in aircraft construction, a 5(6)-axis numerically controlled riveter has been developed and constructed. This riveter can, due to its high degree of automation, rivet spherically shaped partial shells more economically than riveters now available on the market. Newly developed robot technology for the emplacement and binding of clips is also discussed. C.D.

**A83-47185#**

### **TEN YEARS OF PROMOTING THE DEVELOPMENT OF AIR TRANSPORT RESEARCH [10 JAHRE FOERDERUNG DER LUFTFAHRTFORSCHUNG]**

H. HERTRICH (Bundesministerium fuer Forschung und Technologie, Bonn, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 32 p. In German. refs

Developments that have taken place during the West German government's promotion of research on air transport are reviewed. The goals of the promotion effort and financial aspects are summarized, and the crucial areas of the program are discussed, including those pertaining to civil aviation whose aim is to insure the role of German industry in the Airbus program as well as to technological efforts in navigation and landing systems, guidance and control, and avionics. Projects whose aim is to reduce the production cost of participating in the Airbus program are summarized. Test sites are described, as are cooperative efforts with a variety of nations and foreign agencies. C.D.

**A83-47190#**

### **TECHNOLOGY TRANSFER FROM THE AIRCRAFT SECTOR TO OTHER SECTORS AS EXEMPLIFIED BY HELICOPTER TECHNOLOGY [TECHNOLOGIETRANSFER VON DER LUFTFAHRTTECHNIK IN ANDERE BRANCHEN AM BEISPIEL DER HUBSCHRAUBERTECHNIK]**

V. VON TEIN (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 50 p. In German.

The benefits of applying helicopter technology to other branches of industry are examined. The history of German helicopter technology is briefly recapitulated, and some general observations

on technology transfer are made. The advantages of helicopter technology applications to familiar technology are outlined, and the refinement of aircraft technology by helicopter technology is briefly summarized. Direct technology transfer in aircraft construction is briefly considered. The use of fiberbound materials in helicopters is discussed, and the transfer of advances in helicopter technology is examined in some detail. This includes the transfer of rotor blade technology, components useful for space flight, for machine and automobile construction, and for wheel and rail applications. C.D.

**A83-47198#**

### **AUTOMATIZED BONDING PROCESS FOR LOAD-BEARING AIRCRAFT CELLULAR STRUCTURAL COMPONENTS IN LIGHT CONTOUR SYSTEMS [AUTOMATISIERTER KLEBEPROZESS FUER TRAGENDE FLUGZEUG-ZELLENBAUTEILE IN LEICHTEN KONTURSYSTEMEN]**

H.-J. RIECKHOF (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 26 p. In German.

The manufacture of the external fuselage structure of Airbus aircraft which are currently being built makes use, in part, of bonding procedures. The employed method is characterized by an optimal surface treatment of aluminum components by means of a chemical/galvanic approach. The employed adhesive system is based on the use of an adhesive foil made of a modified epoxy resin. Curing involves the exposure of the assembled components to a temperature of 120 C and a pressure of approximately 3 bar in an autoclave. A new manufacturing technology for the fabrication of large bonded aircraft components was developed by a German aerospace company during the time from 1979 to 1982. The automation of the various procedures involved in the bonding process is to provide the basis for an employment of more cost-efficient production operations. G.R.

**A83-47204#**

### **DEVELOPMENT OF AERODYNAMICAL TECHNOLOGY FOR LARGE CIVIL AVIATION AIRCRAFT [AERODYNAMISCHE TECHNOLOGIEENTWICKLUNG FUER ZIVILE GROSSFLUGZEUGE]**

B. EWALD and J. SZODRUCH (Vereinigte Flugtechnische Werke GmbH, Bremen, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 76 p. In German. refs

Progress on the development of an integrated wing-engine system and on airfoil modification for increasing lift in future Airbus variants is discussed. Theoretical and experimental work on transonic wing technology and on thrust-boundary layer control is addressed. Work on a wing with strong interference and on a flap system for the transonic wing is examined. Two lift increase programs are analyzed and results are presented. Wing modifications and developmental steps elsewhere on the aircraft are considered. C.D.

**A83-47205#**

## **LONG-TERM OPERATIONAL TESTING OF CFRP SPOILERS [LANGZEIT-BETRIEBSERPROBUNG VON CFK-SPOILERN]**

G. PORSCHE (Vereinigte Flugtechnische Werke GmbH, Bremen, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 20 p. In German.

The preliminary results of four years of in-use testing of 13 pairs of CFRP spoiler components on the wings of A-300 Airbus passenger aircraft are presented. The aircraft operated in temperate and tropical regions, and the test procedures comprised visual inspection every 300 flight hours, auscultation every 600 flight hours, and weighing of small CFRP segments attached to the spoilers every 2000-3000 flight hours (about once a year). It is found that the spoilers give good service with no loss of stiffness and no abnormal moisture uptake. Al-foil layers covering some of the test spoilers had no effect on moisture uptake. A need for careful structure-based training for the auscultation-test personnel is identified. The damage which occurred during the tests is mainly attributed to handling rather than flight loading; the damage was easily repairable using available techniques and materials. T.K.

**A83-47211#**

## **METHOD OF CONSTRUCTION AND FABRICATION PROCEDURES FOR THE A300-RUDDER UNIT, USING A CARBON-FIBER TYPE OF CONSTRUCTION [BAUWEISE UND FERTIGUNGSVERFAHREN DES A300-SEITENLEITWERKS IN KOFLEFASERBAUWEISE]**

K. H. HEIDTMAN (Messerschmitt-Boelkow-Blohm GmbH, Hamburg, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 34 p. In German.

The present investigation is concerned with a research project which was initiated in West Germany at the end of 1978. This project involves the utilization of fibrous composites for the construction of the A300 rudder unit. Attention is given to details of program planning, scheduling, the design criteria of structure mechanics, design details and approaches for implementing them, material investigations, material parameters, aspects of chemical characterization of the materials, contact corrosion between carbon composites and metals, and studies regarding the effect of atmospheric temperature and humidity on the fiber-resin systems. The influence of preconditioning on the static strength characteristics of carbon composites is discussed along with the drying of carbon-composite laminates as a consequence of solar heating, environmental conditions in verification tests, tests conducted with structural components, and plans for a continuation of the project. G.R.

**A83-47214#**

## **THE APPLICATION OF AERONAUTICAL TECHNOLOGY TO THE CONSTRUCTION OF MACHINES AND VEHICLES [DIE ANWENDUNG VON LUFTFAHRT-TECHNOLOGIEN IM MASCHINEN- UND FAHRZEUGBAU]**

K. D. COLLMANN (Messerschmitt-Boelkow-Blohm GmbH, Hamburg, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 28 p. In German.

The transfer of flight technology to other industries is illustrated. Topics discussed include numerical control of manufacturing processes, multiple-coordinate measuring systems for automotive wind-tunnel studies, aerodynamic investigations of high-speed trains, the use of turbulent-chamber devices for dust removal, and the aerodynamic evaluation of emergency smoke-exhausting plants. Photographs and drawings of some typical installations are provided. T.K.

**A83-47654**

## **MAINTENANCE ASPECTS OF MODERN AVIONICS**

IR. W. BROUWER (KLM Royal Dutch Airlines, Engineering and Maintenance Div., Schiphol Airport, Netherlands) Aircraft Engineering (ISSN 0002-2667), vol. 55, Aug. 1983, p. 2-10.

The personnel, equipment, scheduling, costs, and significance of repair programs for modern, digital avionics are examined. It is noted that although the avionics comprise only a small fraction of the costs of large aircraft, their maintenance requires up to 25 percent of the total maintenance schedule. The flight management computer enables optimized, efficient flight with large, flexible aircraft, and the MBTF for the avionics systems is increasing. The implementation of line replaceable units (LRU) has lowered aircraft downtime through modular removal and replacement of defective equipment, which can then be refurbished for reuse away from the aircraft. Built in test equipment (BITE) aids in locating faults without pulling modules. Technicians are nominally trained to acquire expertise in one LRU in order to increase reliability of the LRUs. The growing complexity of the modular parts, though, is lengthening the time necessary to gain expertise on the equipment. M.S.K.

**A83-48219#**

## **CORRELATION OF FLIGHT TEST AND ANALYTIC M-ON-N AIR COMBAT EXCHANGE RATIOS**

D. S. HAGUE (Aerophysics Research Corp., Bellevue, WA) Journal of Aircraft (ISSN 0021-8669), vol. 20, Oct. 1983, p. 877-881.

(Contract F33615-80-C-3003)

Previously cited in issue 19, p. 2967, Accession no. A82-39105

**A83-48326#**

## **ARMY AIRCRAFT REQUIREMENTS IN THE 1990'S - A VIEW FORWARD**

D. P. SCHRAGE (U.S. Army, Aviation Research and Development Command, St. Louis, MO) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 6 p. (AIAA PAPER 83-2434)

The recently completed U.S. Army Aviation Modernization Plan (AAMP) seeks to both improve combat capability and meet funding constraints through the acquisition of a mix of new aircraft and improved current aircraft. Attention is presently given to the aircraft types through which AAMP will fulfill the requirements of the Air/Land Battle 2000 combat scenario in the decade of the 1990s. These aircraft will include the LHX light helicopter and ACH-XX advanced cargo helicopter. The expanded use of such remotely piloted vehicles as the Aquila is discussed, as is the alternative use of either Preplanned Product Improvement or Block Improvement of aircraft types in an evolutionary insertion of advanced technology through the upgrading of those deployed subsystems offering the greatest benefits. O.C.

**A83-48333#**

## **ENHANCED AIRCRAFT STRUCTURAL MAINTENANCE USING ORGANIC DEPOT DAMAGE TOLERANCE ANALYSIS**

T. F. CHRISTIAN, JR. (USAF, Warner Robins Air Logistics Center, Robins AFB, GA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 9 p. refs (AIAA PAPER 83-2450)

This paper presents an improved method of aircraft force structural maintenance using durability and damage tolerance analysis techniques at the U.S. Air Logistics Commands Air Logistic Centers. The deficiencies of the old method are discussed and the rationale for the new procedure is developed. The flight-by-flight crack growth methodology is explained and the salient benefits of its application given. Future trends and additional potential applications are also briefly outlined. Author

A83-48359#

**WARTIME MAINTENANCE IMPACT ON AIRCRAFT AVAILABILITY QUANTIFYING THE R&D INVESTMENT PAYOFF**

S. J. GUILFOOS and L. M. DECKER (USAF, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 9 p. refs  
(AIAA PAPER 83-2515)

Methods for improving the availability of aircraft in wartime by reducing maintenance time are reviewed. Attention is focused on aircraft turn time, i.e., flying time, maintenance time, and available time. A numerical model is developed for aircraft availability, based on the probability that, in consideration of the failure rates of the aircraft's subcomponents, the aircraft will be prepared to fly. Increases in the availability time are necessary to offset a perceived shortage of military manpower in the age groups generally assigned to logistics support. It is recommended that maintainability and reparability be incorporated early in the design phase. The sensitivity of the aircraft availability to reduced maintenance times and the possibility that availability increases by means of reduced maintenance time could replace acquisition of new aircraft were assessed. Reduced maintenance was found to offer significantly higher operational performance. A research and development program to introduce maintenance considerations early in the design phase is recommended. M.S.K.

A83-48361#

**SCHEDULED DEPOT MAINTENANCE OF NAVAL AIRCRAFT - HOW OFTEN?**

G. M. STURM (U.S. Navy, Naval Air Rework Facility, San Diego, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 6 p.  
(AIAA PAPER 83-2517)

A study of the depot-maintenance requirements of US Navy F-4N and F-4J aircraft is reported. Data on component deficiencies were collected during 1978 and 1979 on 20 F-4N and 30 F-4J aircraft at the time of their scheduled depot maintenance. Deficiencies were classified and weighted, in terms of significance, and service histories were recorded. Careful analysis of this large data base allowed the inspection intervals for individual components and for the aircraft as a whole to be increased. Statistical analysis using scattergraphs and multiple-regression techniques found no significant correlations between aircraft defects and aircraft usage history. A general and predictable trend relating poorer material condition to longer tours of service and more flight hours was observed, but there were numerous exceptions. T.K.

A83-48378#

**COMPARATIVE COST OF MILITARY AIRCRAFT - FICTION VERSUS FACT**

H. F. MARX (Northrop Corp., Aircraft Div., Hawthorne, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 11 p. refs  
(AIAA PAPER 83-2565)

This paper describes why most of the comparative costs of weapon systems, especially aircraft, which are reported by the media are either grossly distorted or completely wrong. It delineates four distinct fallacies, associated with material released to the media, explains why each is wrong, and proposes a practical, desirable, and almost painless solution to the problem. Author

A83-48889#

**IMPACT OF COMPOSITES ON FIGHTER AIRCRAFT. II - COMPOSITES NEW LOOK TO THE AIRCRAFT PRODUCTION LINE**

J. F. SCHIER and R. J. JUERGENS (McDonnell Aircraft Co., St. Louis, MO) Astronautics and Aeronautics (ISSN 0004-6213), vol. 21, Oct. 1983, p. 41-45.

Production techniques, tools, and procedures employed to lower costs of composite components while ensuring quality control are

discussed. Attention is given to nesting and laser cutting guided by computer in order to maximize material use, and mechanical, chemical, and rheological testing to maintain quality. Parts have been produced for the F-15, F/A-18, and AV-8B on a production line basis, which required construction of new facilities and installation of new production machinery. In-flight performance has exceeded an average of 10,000 hr between maintenance actions, compared to 12,000 hr for aluminum components. The capability for effective repair of bullet holes and larger apertures cut through composite panels to make interior repairs has been demonstrated. D.H.K.

A83-49176

**INTERNATIONAL SYMPOSIUM ON AEROELASTICITY, NUREMBERG, WEST GERMANY, OCTOBER 5-7, 1981, COLLECTED PAPERS**

Symposium supported by the Bundesministerium fuer Forschung und Technologie. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, 386 p.  
(DGLR BERICHT 82-01)

Topics related to unsteady aerodynamics are discussed, taking into account aeroelasticity at separated flow, the investigation of the stall flutter of an airfoil with a semiempirical model of two-dimensional flow, transonic effects on helicopter rotor blades, recent developments in unsteady pressure measurement techniques, an extension of the transonic perturbation approach to three-dimensional problems, unsteady airloads on supercritical wings, and a field panel method for the calculation of inviscid transonic flow about thin oscillating airfoils with shocks. Other subjects explored are concerned with system identification, structure modeling and optimization, and active flutter suppression and vibration reduction. Attention is given to a survey of aeroelastic wind tunnel and flight testing methods employed by a West German aerospace company, practical applications of system identification in flutter testing, the calculation of modal characteristics from measured quasi-normal mode information, structural optimization with aeroelastic constraints, and investigations of hingeless rotor stability. G.R.

A83-49576#

**AIR FORCE AERONAUTICAL SYSTEMS THE 1990'S - A MAJOR SHIFT**

S. A. TREMAINE (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 6 p.  
(AIAA PAPER 83-2433)

Aeronautical systems division (ASD) planning by the U.S.A.F. proceeds from analyses and projections from mini-analyses in military mission areas, analyses of military combat scenarios anywhere in the world, and interaction with command plans. Recent efforts have focused on defense against chemical and biological warfare, enhancing and maintaining the penetration capability of the B-1B, the ALCM, and the FB-111 through the 1990s, and projections of the aeronautical needs into the next century. Attention has also been devoted to tactical modernization, maintaining the usefulness of IR electrooptical equipment on the air-to-ground missiles used in land battles, exploring concepts for an advanced tactical fighter (ATF), and investigating the designs and applications of a transatmospheric vehicle (TAV). The ATF will feature VHSIC avionics, composite airframe, a high T/W engine with electronic controls, and thrust vectoring. The TAV system will furnish a global response capability to provide reconnaissance, force projection, strategic defense, and interdiction support. M.S.K.

## 01 AERONAUTICS (GENERAL)

**A83-49578#**

### **AVIONICS BUILT-IN-TEST EFFECTIVENESS AND LIFE CYCLE COST**

C. PALAZZO and M. ROSENFELD (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 7 p.  
(AIAA PAPER 83-2448)

Results of an investigation into the effectiveness of built-in-test (BIT) on aircraft weapon systems and its impact on operational assessability and life cycle cost (LCC) are presented herein. BIT effectiveness was found to be high in current operational systems although errors in data collection and interpretation precluded highly accurate measurements. Low BIT effectiveness had a negligible effect on logistic support costs (LSC), particularly for avionic units with moderate to high reliabilities. It was concluded that a major reason for improving BIT effectiveness was to increase its ability to determine the status of mission essential subsystems (i.e., increase operational assessability). Author

**A83-49586#**

### **DESIGNING FOR SUPPORTABILITY AND COST EFFECTIVENESS**

G. WEINSTEIN (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 4 p.  
(AIAA PAPER 83-2499)

It is pointed out that logistic support requirements for an aircraft are affected by each act and decision made through the system life cycle. Logistic support planning must, therefore, begin concurrent with the system concept definition. Aspects of logistic support planning are discussed, taking into account the ILS detail specification (ILSDS), the integrated logistic support plan (ILSP), and the logistics support analysis (LSA) plan. Preconcept definition supportability data are considered along with ILS goals. Attention is given to maintenance man-hour limits, personnel manning minimization, support equipment minimization, aspects of maintenance planning, and life cycle costs (LCC). G.R.

**N83-34885\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

### **DESIGN OF A MICROPROCESSOR-BASED CONTROL, INTERFACE AND MONITORING (CIM UNIT FOR TURBINE ENGINE CONTROLS RESEARCH**

J. C. DELAAT and J. F. SOEDER Jun. 1983 39 p refs  
(NASA-TM-83433; E-1725; NAS 1.15:83433) Avail: NTIS HC A03/MF A01 CSCL 01B

High speed minicomputers were used in the past to implement advanced digital control algorithms for turbine engines. These minicomputers are typically large and expensive. It is desirable for a number of reasons to use microprocessor-based systems for future controls research. They are relatively compact, inexpensive, and are representative of the hardware that would be used for actual engine-mounted controls. The Control, Interface, and Monitoring Unit (CIM) contains a microprocessor-based controls computer, necessary interface hardware and a system to monitor while it is running an engine. It is presently being used to evaluate an advanced turbofan engine control algorithm. Author

**N83-34886\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

### **THE TREND OF FUTURE GAS TURBINE TECHNOLOGY**

M. J. HARTMAN 1983 16 p Presented at the Tokyo Intern. Gas Turbine Congr., Tokyo, 23-28 Oct. 1983; sponsored by GTSJ, AMSE, IMechE, JSME, and VDI  
(NASA-TM-83505; E-1844; NAS 1.15:83505) Avail: NTIS HC A02/MF A01 CSCL 01B

Turbomachinery system component research to advance the technology of aviation turbofan and turbojet engines is discussed. Areas of research include compressors, turbines, internal flow analysis, combustion, fuels, materials, structures, bearings, seals, lubrication, dynamics and controls, and instrumentation. A review

of the research directions being taken in these areas and the steady advances being made provides a reasonable glimpse at gas turbine technology of the future. Author

**N83-34888#** RAND Corp., Santa Monica, Calif.

### **INCREASING FUTURE FIGHTER WEAPON SYSTEM PERFORMANCE BY INTEGRATING BASING, SUPPORT AND AIR VEHICLE REQUIREMENTS Interim Report**

M. B. BERMAN and C. L. BATTEN Apr. 1983 37 p refs  
(Contract F49620-82-C-0018)  
(AD-A129039; RAND/N-1985-1-AF) Avail: NTIS HC A03/MF A01 CSCL 01C

This report argues that the Air Force should consider alternative basing and support characteristics before completing concept formulation for the Advanced Technical Fighter. In so doing, the Air Force could integrate these characteristics using a methodology described in this Note. This methodology aims at identifying the best match between specific air vehicle characteristics and such basing and support improvements as dispersed and/or rearward basing, short-take-off-and-landing and rough-field-landing capabilities, increased combat range capabilities, improved equipment reliability, and decreased reliance on support equipment and personnel. GRA

**N83-34889#** Federal Aviation Administration, Washington, D.C. **THE FAA (FEDERAL AVIATION ADMINISTRATION) AIR TRAFFIC ACTIVITY FY 1982**

N. TREMBLEY 30 Sep. 1982 225 p refs  
(AD-A128702; FAA-AMS-220; PB83-202283) Avail: NTIS HC A10/MF A01 CSCL 17G

Terminal and enroute air traffic activity information of the National Airspace System is provided, aircraft handled under instrument flight rules are shown. Summaries of aircraft operations at FAA operated towers by type of operation, aircraft category, state and region are excluded. Instrument operations at towers and radar approach control facilities are also included. Rank order tables are provided to give the user a picture of the busiest facilities in the system. Historical tables are included where possible to show changes in growth. S.L.

**N83-34890#** Southwest Research Inst., San Antonio, Tex.

### **DEMONSTRATION AND ANALYSIS OF AN IMPROVED NONDESTRUCTIVE EVALUATION (NDE) METHOD FOR ROTARY WING HEAD SPINDLE THREADS Final Report**

G. L. BURKHARDT and C. M. TELLER Jun. 1982 24 p refs  
(Contract DLA900-79-C-1266)  
(AD-A128741; SWRI-15-5607-809) Avail: NTIS HC A02/MF A01 CSCL 01C

Present inspection methods for the Black Hawk helicopter rotary wing head spindle require almost complete disassembly of the rotary wing head and hub assemblies to expose the failure critical threads for inspection. Even with direct access to the threads, detection of fatigue cracks in the thread roots is very difficult using penetrant and visual methods. An improved nondestructive evaluation method for the spindle using the electric current perturbation method which requires only minimal disassembly for safety-of-flight inspections was demonstrated. High sensitivity inspection of the spindle threads applicable to routine teardown maintenance was also demonstrated. GRA

**N83-34891#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

### **ADVANCES IN SENSORS AND THEIR INTEGRATION INTO AIRCRAFT GUIDANCE AND CONTROL SYSTEMS**

J. L. HOLLINGTON, ed. (Smiths Industries, Cheltenham, England) Loughton, England Jun. 1983 151 p refs  
(AGARD-AG-272; ISBN-92-835-1451-3) Avail: NTIS HC A08/MF A01

Advanced in electro-optic sensors and airborne radar, new types of inertial sensor, low cost fluidic sensors, the measurement of airspeed and windshear with an airborne laser, an application of analytical redundancy, and the integration of a new sensor on to an existing aircraft are topics of discussion.



**N83-35992\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**EXPLOSIVELY ACTIVATED EGRESS AREA Patent**

L. J. BEMENT (LTV Aerospace Corp., Hampton, Va.) and J. W. BAILEY, inventors (to NASA) (LTV Aerospace Corp., Hampton, Va.) 4 Oct. 1983 10 p Filed 30 Apr. 1981 Supersedes N81-29107 (19 - 20, p 2722) Sponsored by NASA (NASA-CASE-LAR-12624-1; US-PATENT-4,407,468; US-PATENT-APPL-SN-259209; US-PATENT-CLASS-244-137P; US-PATENT-CLASS-89-1B; US-PATENT-CLASS-102-378) Avail: US Patent and Trademark Office CSCI 01B

A lightweight, add on structure which employs linear shaped pyrotechnic charges to smoothly cut an airframe along an egress area periphery is provided. It compromises reaction surfaces attached to the exterior surface of the airframe's skin and is designed to restrict the skin deflection. That portion of the airframe within the egress area periphery is jettisoned. Retention surfaces and sealing walls are attached to the interior surface of the airframe's skin and are designed to shield the interior of the aircraft during detonation of the pyrotechnic charges.

Official Gazette of the U.S. Patent and Trademark Office

**N83-35993#** Army Aviation Research and Development Command, St. Louis, Mo. Directorate for Plans and Analysis.

**HISTORICAL RESEARCH AND DEVELOPMENT INFLATION INDICES FOR ARMY FIXED AND ROTOR WINGED AIRCRAFT Annual Report**

W. CROSBY Mar. 1983 25 p refs (AD-A129317; USAVRADCOM-TM-83-F-1) Avail: NTIS HC A02/MF A01 CSCI 05A

This Technical Memorandum is a continuation of previous efforts to develop the necessary rationale and methodology needed in order to construct historical inflation indices, in the Research and Development (R&D) area, relative to Army aircraft. The R&D historical indices, and the sub-indices from which they are derived, are presented in the appendices to this report for the period FY68 through FY82. A computer program is utilized to make the necessary mathematical calculations. Data sources of this report were the Office of Personnel Management (OPM) and the Bureau of Labor Statistics (BLS). OPM supplied data on government salaries. BLS furnished data on industry salaries and thirteen (13) different materials. The computer program prints the R&D historical inflation indices and sub-indices by fiscal year as shown in Appendices A, C, D and E. Author (GRA)

## 02

### AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

**A83-47888#**

**NEGATIVE INCIDENCE FLOW OVER A TURBINE ROTOR BLADE**

H. D. JOSLYN and R. P. DRING (United Technologies Research Center, East Hartford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. refs (Contract F33615-80-C-2008) (ASME PAPER 83-GT-23)

The operation of variable cycle gas turbines at negative incidence can result in highly three dimensional separated flows on the turbine rotor pressure surface. These flows can impact both performance and durability. The present program was conducted to experimentally study the behavior of surface flow on a large scale axial flow turbine rotor with incidence varying up to and including negative incidence separation. Fullspan pressure distributions and surface flow visualization were acquired over a range of incidence. The data indicate that at large negative

incidence, pressure surface separation occurred and extended to 60 percent chord at midspan. These separated flows were simulated at midspan by applying potential flow theory to match the measured pressure distributions. Author

**A83-47889#**

**MEASUREMENTS OF SECONDARY FLOWS WITHIN A CASCADE OF CURVED BLADES AND IN THE WAKE OF THE CASCADE**

R. LASSER (Bell Telephone Laboratories, Inc., Holmdel, NJ) and W. T. ROULEAU (Carnegie-Mellon University, Pittsburgh, PA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. Research supported by the Benedum Foundation. refs

(ASME PAPER 83-GT-24)

A laser-Doppler anemometer was used to measure the three-dimensional velocity field within a typical turbine blade cascade. The blades had a 12.7 cm chord, a turning angle of 104.8 deg, and a shape conforming to the camber line of a commercial turboexpander. The cascade was operated at a Reynolds number of 125,000. Strong secondary velocities, ranging up to 35 percent of the primary flow velocity, were found, resulting from the development of counter-rotating vortices within the blade passages. Large midspan velocity defects in the primary flow were coincident with these high secondary flows. The secondary flow persisted throughout the near wake region. Author

**A83-47900#**

**A NAVIER-STOKES ANALYSIS OF THREE-DIMENSIONAL TURBULENT FLOWS INSIDE TURBINE BLADE ROWS AT DESIGN AND OFF-DESIGN CONDITIONS**

C. HAH (General Electric Co., Fluid Mechanics and Combustion Branch, Schenectady, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. refs (ASME PAPER 83-GT-40)

A numerical scheme based on the compressible Navier-Stokes equation has been developed for three-dimensional turbulent flows inside turbine blade rows. The numerical scheme is based on a fully conservative control volume formulation and solves the governing equations in fully elliptic form. Higher order discretizations are used for the convection term to reduce the numerical diffusion. An algebraic Reynolds stress model modified for the effects of the streamline curvature and the rotation is used for the closure of the governing equations. General coordinate transformations are used to represent the complex blade geometry accurately, and a grid generation technique based on elliptic partial differential equations is employed. Comparisons with the experimental data show that various complex three-dimensional viscous flow phenomena (three-dimensional flow separation near the leading edge, formation of the horseshoe vortex, etc.) are well predicted with the present method. Author

**A83-47901\*#** Delaware Univ., Newark.

**INLET-FAN FLOW FIELD COMPUTATION**

M. D. MATWEY, B. S. SEIDEL (Delaware University, Newark, DE), and C. A. FARRELL, JR. (NASA, Lewis Research Center, Cleveland, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs (Contract NSG-3270; NAG3-121) (ASME PAPER 83-GT-41)

The flow field of a tilt-nacelle inlet-fan combination used for V/STOL aircraft is studied. Under certain flight conditions the inlet is subjected to high angles of attack and/or yaw. This produces a non-uniform or distorted flow field at the fan-face that can lead to large blade stresses. This paper presents an analytical approach to the coupled inlet-fan problem. The nacelle is modelled by a distribution of source panels and the fan by a distribution of radial vortices. A modified actuator disc with losses and a quasi-steady rotor response is used to derive the boundary condition at the fan-face. An example of the calculation is shown. Author

## 02 AERODYNAMICS

**A83-47909\*#** General Motors Corp., Indianapolis, Ind.  
**AN EXPERIMENTAL INVESTIGATION OF ENDWALL HEAT TRANSFER AND AERODYNAMICS IN A LINEAR VANE CASCADE**

R. E. YORK, L. D. HYLTON, and M. S. MIHELIC (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. USAF-NASA-supported research. refs  
(ASME PAPER 83-GT-52)

The purpose of this experimental investigation was to produce a data base of endwall heat transfer data under conditions that simulate those in the passage of the first-stage stator in advanced turbine engines. The data base is intended to be sufficiently complete to provide verification data for refined computational models, and to provide a basis for advanced core engine endwall cooling designs. A linear, two-dimensional cascade was used to generate the data base. The test plan provided data to examine the effects of exit Mach number, exit Reynolds number, inlet boundary layer thickness, gas-to-wall temperature ratio, inlet pressure gradients, and inlet temperature gradients. The data generated consist of inlet, intrapassage, and exit aerodynamic data plus intrapassage endwall heat flux, adiabatic wall temperature measurements, and inlet turbulence data. Author

**A83-47917#**  
**DISTINCTION BETWEEN DIFFERENT TYPES OF IMPELLER AND DIFFUSER ROTATING STALL IN A CENTRIFUGAL COMPRESSOR WITH VANELESS DIFFUSER**

P. FRIGNE and R. VAN DEN BRAEMBUSSCHE (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs  
(ASME PAPER 83-GT-61)

This paper describes the results of an experimental investigation of the subsynchronous rotating flow patterns in a centrifugal compressor with vaneless diffuser. Several compressor configurations have been examined by means of hot wire anemometry. Fourier analysis allowed one to distinguish between the different modes of unstable operation. For both impeller and diffuser rotating stall, comparison is made between the amplitude, frequency, and periodicity of the induced velocity fluctuations. The results are further cross-checked with other experimental data. Author

**A83-47918#**  
**PERFORMANCE EVALUATION OF CENTRIFUGAL COMPRESSOR IMPELLERS USING THREE-DIMENSIONAL VISCOUS FLOW CALCULATIONS**

J. MOORE, J. G. MOORE (Virginia Polytechnic Institute and State University, Blacksburg, VA), and P. H. TIMMIS (Rolls-Royce, Ltd., Aero Div., Leavesden, Herts., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs  
(ASME PAPER 83-GT-62)

Calculations of three-dimensional viscous flow in the impeller of a centrifugal compressor are used as the basis of a study of the thermodynamics of the compressor process. Flow in a high hub-tip ratio low specific speed impeller of approximately 3.4:1 pressure ratio is considered. Results are presented showing the work and loss production processes in the impeller. A strong influence of tip-leakage flow on the performance of this unshrouded wheel is found. Author

**A83-47920#**  
**A CAD METHOD FOR CENTRIFUGAL COMPRESSOR IMPELLERS**

H. KRAIN (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Antriebstechnik, Cologne, West Germany) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs  
(ASME PAPER 83-GT-65)

A computer-aided design method (CAD) has been developed for radially ending and backswept centrifugal compressor impellers. The geometrical concept introduced for generating the impeller geometry takes care of numerical manufacturing, as well as aerodynamic aspects. The fluid dynamic calculation method applied is based on a quasi-three-dimensional approach coupled with a boundary layer calculation method. Detailed quantitative comparisons between theoretical data and laser measurements taken within a radially ending impeller revealed predominantly good agreement. Backswept impellers of different size and shape have been designed by the approach presented. Author

**A83-47941\*#** Cincinnati Univ., Ohio.  
**EFFECT OF PARTICLE PRESENCE ON THE INCOMPRESSIBLE INVISCID FLOW THROUGH A TWO DIMENSIONAL COMPRESSOR CASCADE**

C. BALAN and W. TABAKOFF (Cincinnati, University, Cincinnati, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. refs  
(Contract NSG-3218; DAAG29-82-K-0029)  
(ASME PAPER 83-GT-95)

A computational model is developed for calculating the flow field, in the presence of solid particles, through a two-dimensional compressor cascade. Results show that the effect of solid particles on the flow field contributes to the bending of the streamlines toward the blade suction surface. It is determined that the difference in the pressure coefficient for particulate flow, with 165 micron diameter for the particles, is of the order of 3 percent over the air only flow. The change in the pressure coefficients is shown to be much larger for very small particles. It was found that the total pressure loss associated with the particulate flow is very high for very small particles as compared with large particles. The total pressure loss is also shown to be higher for accelerating flow than for decelerating flow. The total pressure loss is shown to be directly proportional to the particle concentration. It is concluded that significant reductions in performance can occur in a real multistage machine due to the changes in the pressure ratios, particularly if the suspended matter is small particles. N.B.

**A83-48011#**  
**THREE DIMENSIONAL INVISCID COMPUTATION OF AN IMPELLER FLOW**

T. C. PRINCE and A. C. BRYANS (General Electric Co., Aircraft Engine Business Group, Lynn, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p.  
(ASME PAPER 83-GT-210)

The flow in a centrifugal impeller is analyzed by a quasi-three-dimensional streamline curvature method, by a three-dimensional Euler code, and by a three-dimensional finite element potential flow method. Comparison with Eckardt's published data for a backswept impeller shows that full three-dimensional methods better predict the loading at the hub and shroud. Author

**A83-48012\*#** United Technologies Corp., East Hartford, Conn.  
**DEVELOPMENT OF CONTROLLED DIFFUSION AIRFOILS FOR MULTISTAGE COMPRESSOR APPLICATION**  
 D. E. HOBBS and H. D. WEINGOLD (United Technologies Corp., Pratt and Whitney Group, East Hartford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 11 p. refs (Contract N00019-77-C-0546; NAS3-22008) (ASME PAPER 83-GT-211)

A series of Controlled Diffusion Airfoils has been developed for multistage compressor application. These airfoils are designed analytically to be shock free at transonic Mach number and to avoid suction surface boundary layer separation for a range of inlet conditions necessary for stable compressor operation. They have demonstrated, in cascade testing, higher critical Mach number, higher incidence range, and higher loading capability than standard series airfoils designed for equivalent aerodynamic requirements. These airfoils have been shown, in single and multistage rig testing, to provide high efficiency, high loading capability, and ease of stage matching, leading to reduced development costs and improved surge margin. The Controlled Diffusion Airfoil profile shapes tend to have thicker leading and trailing edges than their standard series counterparts, leading to improved compressor durability. Author

**A83-48132#**  
**EFFECTS OF EXTERNAL BURNING ON SPIKE-INDUCED SEPARATED FLOW**

J. P. REDING and D. M. JECMEN (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of Spacecraft and Rockets (ISSN 0022-4560), vol. 20, Sept.-Oct. 1983, p. 452, 453.

Previously cited in issue 19, p. 2971, Accession no. A82-39127

**A83-48133#**  
**CHEMICAL EQUILIBRIUM LAMINAR OR TURBULENT THREE-DIMENSIONAL VISCOUS SHOCK-LAYER FLOWS**

K. Y. SZEMA, C. H. LEWIS (Virginia Polytechnic Institute and State University, Blacksburg, VA), and R. R. THAREJA Journal of Spacecraft and Rockets (ISSN 0022-4560), vol. 20, Sept.-Oct. 1983, p. 454-460. refs

Previously cited in issue 07, p. 966, Accession no. A82-19792

**A83-48134#**  
**OPTIMIZATION OF WAVERIDER CONFIGURATIONS GENERATED FROM AXISYMMETRIC CONICAL FLOWS**

M. L. RASMUSSEN, M. C. JISCHKE (Oklahoma, University, Norman, OK), and B. S. KIM Journal of Spacecraft and Rockets (ISSN 0022-4560), vol. 20, Sept.-Oct. 1983, p. 461-469. refs (Contract F08635-80-K-0340)

Previously cited in issue 19, p. 2970, Accession no. A82-39086

**A83-48143**  
**CALCULATION OF POTENTIAL FLOW ABOUT ARBITRARY THREE DIMENSIONAL WINGS USING INTERNAL SINGULARITY DISTRIBUTIONS**

N. SINGH, G. BANDYOPADHYAY, and B. C. BASU (Indian Institute of Technology, Kharagpur, India) Aeronautical Quarterly (ISSN 0001-9259), vol. 34, Aug. 1983, p. 197-211. refs

A first order panel method has been developed for calculating the incompressible potential flow about arbitrary three-dimensional wings. The method utilizes a distribution of source and vorticity singularities on the mean camber surface of the wing and solves for the distribution by satisfying the boundary condition of zero normal flow at selected points on the surface of the wing. The method takes less computing time compared to other existing first order methods for the comparable numerical accuracy. This method can handle wings having cusped trailing edges and thin sections. Author

**A83-48144**  
**ON THE ENERGY CHARACTERISTICS OF THE AERODYNAMIC MATRIX AND THE RELATIONSHIP TO POSSIBLE FLUTTER**  
 J. G. JONES (Royal Aircraft Establishment, Farnborough, Hants., England) Aeronautical Quarterly (ISSN 0001-9259), vol. 34, Aug. 1983, p. 212-225. refs

The problem of energy transfer between an airstream and a wing in sinusoidal motion has been investigated by a series of authors beginning with Frazer who in 1939 considered the power input required to maintain forced oscillations of an aeroplane wing in flight. More recently Nissim introduced an 'aerodynamic energy concept' as the basis for the design of active control systems for flutter suppression. In this paper the author reconsiders the energy characteristics of the aerodynamic matrix in terms of the network concepts of resistive and reactive elements, corresponding to energy dissipation and energy storage respectively. A dual formulation of Nissim's method is described and an extension proposed that takes account of aerodynamic energy storage in addition to aerodynamic energy dissipation. Author

**A83-48145**  
**ADDED FLUID MASS AND THE EQUATIONS OF MOTION OF A PARACHUTE**

J. A. EATON (General Electric Co., Ltd., Mechanical Engineering Laboratory, Whitestone, Leics., England) Aeronautical Quarterly (ISSN 0001-9259), vol. 34, Aug. 1983, p. 226-242. refs

The concept of added mass is outlined and some general conditions for its significance are given. Its implementation in the parachute equations of motion is reviewed, and it is shown that the equations used in earlier treatments are erroneous. A general method for determining the equivalent external forces and moments arising from added mass is given, and the correct, anisotropic forms of the added mass tensor are derived for the six-degree-of-freedom motion in an ideal fluid of rigid body shapes with planar, twofold, and axisymmetry. Full nonlinear solutions of the equation of motion for the axisymmetric parachute are obtained, and the results suggest that added mass effects are more significant than previously predicted. In particular, the component of added mass along the axis of symmetry is found to have a pronounced effect on stability. C.R.

**A83-48211\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**EXPERIMENTAL WING AND CANARD JET-FLAP AERODYNAMICS**

D. B. SMELTZER, D. A. DURSTON (NASA, Ames Research Center, Moffett Field, CA), and V. R. STEWART (Rockwell International Corp., North American Aircraft Div., Columbus, OH) Journal of Aircraft (ISSN 0021-8669), vol. 20, Oct. 1983, p. 833, 834. (AIAA PAPER 83-0081)

The effects of upper surface blowing on the aerodynamics of a 1/2-span wing/body/canard configuration are shown. The results expand a data base that is limited at high subsonic Mach numbers ( $M = 0.6-0.9$ ), data that are needed if computational techniques are to be developed for the complex flowfields generated by jet blowing. At lift coefficients greater than about 1.0, the thrust removed drag coefficient was lower with jet blowing than without jet blowing. This favorable effect increased with increasing jet blowing coefficient, and, for a fixed coefficient, simultaneous wing/canard jet blowing was slightly more effective than blowing either surface alone. Author

**A83-48216#**  
**STRONG PRESSURE WAVES IN AIR-BREATHING ENGINES**  
 V. E. HALOULAKOS (McDonnell Douglas Astronautics Co., Propulsion Dept., Huntington Beach, CA) Journal of Aircraft (ISSN 0021-8669), vol. 20, Oct. 1983, p. 859-865.

Previously cited in issue 19, p. 3267, Accession no. A81-40895

**A83-48220#**

**DRAG OF WINGS WITH CAMBERED AIRFOILS AND PARTIAL LEADING-EDGE SUCTION**

J. DELAURIER (Toronto, University, Downsview, Ontario, Canada) *Journal of Aircraft* (ISSN 0021-8669), vol. 20, Oct. 1983, p. 882-886. Research supported by the Department of Communications of Canada. refs

Traditional methods for wing drag calculation can greatly underestimate the maximum lift/drag ratios of low Reynolds number wings with highly cambered airfoils. The present work gives an alternative method that accounts for camber and leading-edge suction efficiency. Various results are drawn from this, including the conclusion that for zero leading-edge suction, an airfoil may be cambered so as to match the lift/drag ratio of a wing with 100 percent leading-edge suction, at a given lift coefficient. Also shown is an explanation of the parabolic drag behavior of two-dimensional airfoils in terms of partial leading-edge suction. Two comparisons with experiment are made which appear to confirm the reality of the analytical model and show the usefulness of this method for drag prediction. Author

**A83-48221#**

**PAN AIR APPLICATIONS TO COMPLEX CONFIGURATIONS**

A. CENKO (Grumman Aerospace Corp., Bethpage, NY) *Journal of Aircraft* (ISSN 0021-8669), vol. 20, Oct. 1983, p. 887-892. refs

Previously cited in issue 05, p. 577, Accession no. A83-16459

**A83-48222#**

**WAVE DRAG PREDICTION USING A SIMPLIFIED SUPERSONIC AREA RULE**

E. J. JUMPER (USAF, Institute of Technology, Wright-Patterson AFB, OH) *Journal of Aircraft* (ISSN 0021-8669), vol. 20, Oct. 1983, p. 893-895. USAF-supported research. refs

Jones (1955) has first reported the supersonic area rule which has become a commonly used method of determining wave drag. The present investigation is concerned with a modification to the supersonic area rule which greatly simplifies the input data and significantly reduces the complexity and core requirement of the associated computer program. The modification involves the mathematical construction of a simple equivalent body of revolution based on planes cut normal to the fuselage axis of the full aircraft configuration. The supersonic area rule is applied to the axis-normal equivalent body of revolution. According to the results of the investigation, the modified supersonic area rule provides relatively good predictions of the total wave drag for those cases in which the unmodified area rule also yields good results. G.R.

**A83-48368\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**THE EFFECT OF A LEADING-EDGE SLAT ON THE DYNAMIC STALL OF AN OSCILLATING AIRFOIL**

L. W. CARR and K. W. MCALISTER (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 26 p. refs (AIAA PAPER 83-2533)

The dynamic stall characteristics of a slatted airfoil were investigated experimentally on a 2-ft-chord airfoil oscillating in pitch at  $M = 0.2$  for a range of reduced frequency and mean angle of oscillation. The slat produced a flow that remained attached to the airfoil for angles well above those normally attained by the retreating blade of a helicopter during high speed flight. The dynamic stall vortex usually associated with these flight conditions was completely eliminated for all angles under 30 deg. Instantaneous surface pressure, lift, and pitching moment data are presented as a function of incidence throughout the oscillation cycle; a detailed analysis of instantaneous boundary-layer flow behavior for the various test conditions is included. Author

**A83-48449**

**CALCULATION OF FRICTION AND HEAT TRANSFER ON THE PROFILE OF A TURBOMACHINE CASCADE [RASHET TRENIA I TEPLOOTDACHI NA PROFILE RESHETKI TURBOMASHINY]**

G. L. PODVIDZ Akademiia Nauk SSSR, Izvestiia, Energetika i Transport (ISSN 0002-3310), July-Aug. 1983, p. 108-116. In Russian. refs

A nonseparated boundary layer on a cascade profile is investigated on the basis of differential equations of motion and energy. A unified two-part turbulence model is used: an algebraic model of eddy viscosity with a universal law-of-the-wall is applied near the profile contour in the viscous sublayer; and a one-parameter differential model of eddy viscosity is applied outside this sublayer. The model makes it possible to calculate laminar, transition, and turbulent layers on the profile contour. Examples are considered involving the calculation of friction and heat transfer on the profile contour for various values of the outer-flow turbulence. B.J.

**A83-48664**

**A METHOD FOR CALCULATING THE REGIME OF STRONG VISCOUS INTERACTION ON A DELTA WING [OB ODNOM METODE RASHETA REZHIMA SIL'NOGO VIAZKOGO VZAIMODEISTVIA NA TREUGOL'NOM KRYLE]**

G. N. DUDIN and D. O. LYZHIN Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1983, p. 119-124. In Russian. refs

A method is proposed for calculating a three-dimensional boundary layer on a delta wing in the case of strong viscous interaction with an outer hypersonic flow. An iterative procedure is developed at each step of which a function is introduced which is defined on the whole length of the calculation domain and represents the difference between the prescribed pressure distribution and the pressure distribution determined by the solution of the boundary layer equations. This function is employed in an ordinary differential equation of second order with respect to the pressure distribution; the solution of this equation makes it possible to determine a new approximation for the pressure distribution. Results of the numerical solution of the boundary value problem are presented. B.J.

**A83-49177**

**AEROELASTICITY AT SEPARATED FLOW - CONCEPTS AND PROSPECTS**

H. FOERSCHING (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, West Germany) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 1-10. refs

Currently-used concepts and analytical techniques for the treatment of aeroelastic problems of aircraft operating under separated flow conditions are critically reviewed. The corresponding mathematical-physical models proposed and applied at present are briefly discussed, and semi-empirical prediction techniques based thereupon are elucidated. Finally, future developments of numerical analysis applying viscous flow theory are highlighted. Author

**A83-49178**

**TRANSONIC EFFECTS ON HELICOPTER ROTOR BLADES**

H. HUBER, V. MIKULLA, and H. STAHL (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 22-31. refs

This paper summarizes the basic transonic environment of the rotor and describes and discusses the most important consequences on the helicopter high-speed behavior. A survey about the most advanced numerical methods, capable of partially calculating the supersonic flow over the rotor blade, will be presented. Interesting results of computational and experimental (model testing) investigations will be shown, indicating that

unsteadiness is a major feature of the transonic rotor flow. Current work is aimed at the inclusion of the three-dimensional, lifting case. Author

**A83-49179**

**UNSTEADY AIRLOADS ON SUPERCRITICAL WINGS**

H. ZIMMERMANN (Vereinigte Flugtechnische Werke, Bremen, West Germany) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 54-64. refs

The methods developed for the calculation of steady and unsteady pressure distributions in the transonic speed range are derived from the Euler equations, the full-potential equation, and the TSP (transonic small-perturbation) equation for inviscid flow. Attention is given to TSP results without boundary layer corrections, boundary layer and thickness corrections, a description of the Weber-TSP procedure, the results of the Weber-TSP procedure, the applicability of the Weber-TSP procedure for a thinner airfoil, unsteady pressure distributions for the modified Va2 airfoil profile, the extension of the Weber-TSP procedure to swept wings of moderate to large aspect ratio, the flutter behavior for an airfoil in bending and torsion for the transonic region, and a comparison of experimental and theoretical flutter results obtained for a flutter model. G.R.

**A83-49180**

**INVESTIGATION OF THE UNSTEADY AIRLOADS ON AIRFOILS WITH OSCILLATING CONTROL IN SUB- AND TRANSONIC FLOWS**

W. GEISLER and R. VOSS (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, West Germany) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 65-80. refs

Intensive wind tunnel tests involving the Va2 supercritical airfoil section with oscillating trailing edge control have been conducted in a study of active control problems. The calculation of steady and unsteady airloads in low subsonic flow is considered, taking into account the calculation procedure and inviscid results, boundary layer corrections, and the effects of separation. The calculation of unsteady transonic flows around oscillating airfoils by an integral equation method is also discussed, giving attention to questions of basic theory, grid and discretization, the Kutta condition, the numerical procedure, conventional airfoils, and the supercritical airfoil Va2. G.R.

**A83-49300#**

**SUBSONIC DIFFUSER DEVELOPMENT OF ADVANCED TACTICAL AIRCRAFT**

R. A. KITCHEN and D. SEDLOCK (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 19th, Seattle, WA, June 27-29, 1983. 16 p. refs (AIAA PAPER 83-1168)

It has become apparent that the subsonic diffuser design information applicable to the next generation of tactical aircraft is inadequate. In order to meet present challenges in airframe-propulsion integration, it is necessary to establish applicable empirical and semiempirical diffuser design guidelines. Some early work in internal flow systems is considered along with aspects of subsonic diffuser development since WWII. Subsonic diffusers for future tactical aircraft are discussed, taking into account the scope of a program currently being conducted by an American aerospace company, and the current status of this program. G.R.

**A83-49418#**

**EXPERIMENTAL INVESTIGATION OF THE TURBULENT STRUCTURE OF VORTEX WAKES**

O. LEUCHTER and J. L. SOLIGNAC (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (Symposium on Turbulent Shear Flows, 4th, Universitaet Karlsruhe, Karlsruhe, West Germany, Sept. 12-14, 1983) ONERA, TP, no. 1983-107, 1983, 7 p. (ONERA, TP NO. 1983-107)

Two configurations of vertical wake flows are investigated. The first (flow A) corresponds to a double branched trailing vortex, the second (flow B) to the leading edge vortex of a delta wing. Both flows are studied in the presence of a destabilizing adverse pressure gradient leading to vortex breakdown. For various degrees of destabilization, the flow field is explored by means of a two-color laser velocimeter that yields mean velocity and Reynolds stress distributions across the flow. Breakdown is characterized by a strong deceleration of the flow near the axis of the vortex, by a significant decrease of the rotation rate in the center and consequently by a large production of turbulence. When breakdown occurs, both types of flow reveal similar characteristics of the flow structure. However, there are also significant differences, the most important being the abruptness of the breakdown phenomenon and its instability character which is much more pronounced for vortex flow B. Author

**A83-49466**

**THE USE OF COLOURED SMOKE TO VISUALIZE SECONDARY FLOWS IN A TURBINE-BLADE CASCADE**

C. H. SIEVERDING (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium) and P. VAN DEN BOSCHE (Gent, Rijksuniversiteit, Ghent, Belgium) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 134, Sept. 1983, p. 85-89.

A colored-smoke-visualization technique has been developed for the investigation of complex three-dimensional fluid flows. In particular, a colored-smoke wire technique is used for the study of secondary flows in straight turbine cascades. Based on a large number of photographs and direct flow observation, the evolution of horseshoe and passage vortices through a high-turning turbine-blade passage is described. Author

**A83-49585#**

**CHARACTERISTICS OF THE GROUND VORTEX DEVELOPED BY VARIOUS V/STOL JETS AT FORWARD SPEEDS**

V. R. STEWART (Rockwell International Corp., OH), R. E. KUHN (R. E. Kuhn, Inc., Newport News, VA), and M. M. WALTERS (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 11 p. refs (AIAA PAPER 83-2494)

The operation of STOL aircraft near the ground is influenced by the ground effect in several fashions. One significant effect is the ground vortex formed by the reaction of the freestream oncoming air and the wall jet formed by the impingement of the aircraft jets on the ground. The ground vortex can affect the aircraft lift, hot gas reingestion, and inlet object ingestion. This paper presents the results of an experimental program and discusses the formation and magnitude of ground vortex for several STOL configurations including the jet flap. Author

**A83-49596\*#** National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

**APPLICATION OF SLENDER WING BENEFITS TO MILITARY AIRCRAFT**

E. C. POLHAMUS (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 23 p. refs (AIAA PAPER 83-2566)

A review is provided of aerodynamic research conducted at the Langley Research Center with respect to the application of slender wing benefits in the design of high-speed military aircraft,



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taking into account the supersonic performance and leading-edge vortex flow associated with very highly sweptback wings. The beginning of the development of modern classical swept wing jet aircraft is related to the German Me 262 project during World War II. In the U.S., a theoretical study conducted by Jones (1945) pointed out the advantages of the sweptback wing concept. Developments with respect to variable sweep wings are discussed, taking into account early research in 1946, a joint program of the U.S. with the United Kingdom, the tactical aircraft concept, and the important part which the Langley variable-sweep research program played in the development of the F-111, F-14, and B-1. Attention is also given to hybrid wings, vortex flow theory development, and examples of flow design technology. G.R.

**N83-34906\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

### EXPERIMENTS IN A THREE-DIMENSIONAL ADAPTIVE-WALL WIND TUNNEL

E. T. SCHAIERER Sep. 1983 33 p refs  
(NASA-TP-2210; A-9255; NAS 1.60:2210) Avail: NTIS HC A03/MF A01 CSCL 01A

Three dimensional adaptive-wall experiments were performed in the Ames Research Center (ARC) 25- by 13-cm indraft wind tunnel. A semispan wing model was mounted to one sidewall of a test section with solid sidewalls, and slotted top and bottom walls. The test section had separate top and bottom plenums which were divided into streamwise and cross-stream compartments. An iterative procedure was demonstrated for measuring wall interference and for adjusting the plenum compartment pressures to eliminate such interference. The experiments were conducted at a freestream Mach number of 0.60 and model angles of attack between 0 and 6 deg. Although in all the experiments wall interference was reduced after the plenum pressures were adjusted, interference could not be completely eliminated. Author

**N83-34913\*** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

### CHARACTERISTICS OF DOUBLE-CANARD AERODYNAMIC SHAPE CONFIGURATION

W. BAO-XING 6 Apr. 1983 15 p refs Transl. into ENGLISH from Lixue yu Shuian (China), v. 2, no. 2, 1980 p 26-30  
(AD-A128337; FTD-ID(RS)T-0659-82) Avail: NTIS HC A02/MF A01 CSCL 16D

Design of the Canard wing shape and the lift effect, the 'nonlinear' effect of the double Canard type aerodynamic configuration, and control characteristics of the double Canard type aerodynamic configuration are described. Author

**N83-36000\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

### LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A HIGHLY SWEEP, UNTWISTED UNCAMBERED ARROW WING

P. L. COE, JR., S. O. KJELGAARD, and G. L. GENTRY, JR. Oct. 1983 70 p refs  
(NASA-TP-2176; NAS 1.60:2176) Avail: NTIS HC A04/MF A01 CSCL 01A

An investigation was conducted in the Langley 4- by 7-Meter Tunnel to provide a detailed study of wing pressure distributions and forces and moments acting on a highly swept arrow-wing model at low Mach numbers (0.25). A limited investigation of the effect of spoilers at several locations was also conducted. Analysis of the pressure data shows that for the configuration with undeflected leading edges, vortex separation occurs on the outboard wing panel for angles of attack on the order of only 3 deg, whereas conventional leading-edge separation occurs at a nondimensional semispan station of 0.654 for the same incidence angle. The pressure data further show that vortex separation exists at wing stations more inboard for angles of attack on the order of 7 deg and that these vortices move inboard and forward with increasing angle of attack. The force and moment data show the expected nonlinear increments in lift and pitching moment and the increased drag associated with the vortex separation. The pressure data and corresponding force and moment data confirm

that deflecting the entire wing leading edge uniformly to 30 deg is effective in forestalling the onset of flow separation to angles of attack greater than 8.6 deg; however, the inboard portion of the leading edge is overdeflected. The investigation further identifies the contribution of the trailing-edge flap deflection to the leading-edge upwash fields. Author

**N83-36002\*** National Aerospace Lab., Amsterdam (Netherlands).

### CORRELATION OF EXPERIMENTAL AND QUASI-3D THEORETICAL AIRLOADS ON THE OSCILLATING LANN SUPERCRITICAL WING MODEL Final Technical Report, Apr. - Dec. 1982

A. STEIGINGA and H. HOUWINK Wright-Patterson AFB, Ohio AFWAL May 1983 65 p refs  
(Contract F33615-79-C-3030; AF-AFOSR-0136-80; AF PROJ. 2401)  
(AD-A130550; AFWAL-TR-83-3050; NLR-TR-83003-U) Avail: NTIS HC A04/MF A01 CSCL 20D

Correlation of theoretical and experimental unsteady airloads on an oscillating semi-span model of a transport-type supercritical wing (LANN Model) was conducted. The theoretical method is a quasi-3D method which combines 2D transonic small perturbation theory (LTRAN-NLR code) with 2D and 3D subsonic theory (Doublet-Lattice method). Parameters in this correlation are Mach number, frequency, mean angle of attack, and oscillation amplitude. GRA

**N83-36006\*** Lockheed-Georgia Co., Marietta. COMBINED DIRECT/INVERSE THREE-DIMENSIONAL TRANSONIC WING DESIGN Final Report, May 1981 - Sep. 1982

R. A. WEED, L. A. CARLSON, and W. K. ANDERSON May 1983 101 p refs  
(Contract N00167-81-C-0078)  
(AD-A129573; LG83ER0060; DTNSRDC/ASED-CR-03-83) Avail: NTIS HC A06/MF A01 CSCL 20D

A combined direct/inverse three dimensional transonic wing design method is presented. The method is built around the ZEBRA II transonic potential flow solution algorithm to provide a design method that is particularly suited for use on a vector computer. The development of a pilot design computer code and a baseline design/analysis code is described. Results are presented that verify the accuracy and consistency of the design method. Author (GRA)

**N83-36007\*** Boston Univ., Mass. Center for Computational and Applied Dynamics.

### FREE WAKE AERODYNAMIC ANALYSIS OF HELICOPTER ROTORS Final Report, 17 Oct. 1979 - 26 May 1983

L. MORINO, Z. KAPRIELIAN, JR., and S. R. SIPCIC 26 May 1983 99 p refs  
(Contract DAAG29-80-C-0016)  
(AD-A129710; CCAD-TR-83-01; ARO-16294.2-EG) Avail: NTIS HC A05/MF A01 CSCL 20D

A formulation for the free wake analysis of helicopter rotors in incompressible potential flows is presented here. The formulation encompasses both the theory and its numerical implementation. For the case of a single-bladed rotor in hover, the formulation is validated by numerical results which are in good agreement with the generalized wake of Landdgrebe. Extension of the theory to compressible flows is also outlined. These results indicate that the formulation does not require any empirical assumption (such as the rate of contraction of the radius of the wake) in order to avoid numerical instabilities. To our knowledge, the results presented here are the first ones ever obtained not requiring any ad-hoc assumptions in order to avoid such problems. Author (GRA)

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**AIR TRANSPORTATION AND SAFETY**

Includes passenger and cargo air transport operations; and aircraft accidents.

**A83-48176#****LABORATORY AND IN FLIGHT PASSIVE DISCHARGERS CHARACTERIZATION**

J. L. BOULAY and P. LAROCHE (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (International Aerospace and Ground Conference on Lightning and Static Electricity, Fort Worth, TX, June 21-23, 1983) ONERA, TP, no. 1983-54, 1983, 13 p. Research supported by the Direction des Recherches, Etudes et Techniques. refs

(ONERA, TP NO. 1983-54)

Electromagnetic radiation reduction realized with a passive potential discharger employing three complementary methods is discussed. It is noted that characterization in the laboratory with a special experimental configuration gives the reference levels for the threshold and the efficiency of the discharger with differential applied electrical fields. The results obtained from the flight testing of several dischargers are discussed. The threshold, current efficiency, hysteresis, and electromagnetic radiation behavior of the dischargers are analyzed. C.R.

**A83-48180#****A SYSTEMATIC CHARACTERIZATION OF THE EFFECTS OF ATMOSPHERIC ELECTRICITY ON THE OPERATIONAL CONDITIONS OF AIRCRAFT [CARACTERISATION SYSTEMATIQUE DES EFFETS DE L'ELECTRICITEATMOSPHERIQUE SUR LES CONDITIONS OPERATIONNELLES DES AERONEFS]**

J. TAILLET (ONERA, Departement de Physique Generale, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Symposium on Flight Mechanics and System Design: Lessons from Operational Experience, 62nd, Athens, Greece, May 10-13, 1983) ONERA, TP, no. 1983-59, 1983, 15 p. In French. refs

(ONERA, TP NO. 1983-59)

The introduction of composite structures and digital controls in aircraft has raised concerns about the effects of lightning and atmospheric static electricity. Flight trials have been performed with instrumented aircraft in order to characterize and quantify the aircraft-atmospheric electricity interactions, as well as develop a data base that could eventually be used to ameliorate the effects of electromagnetic pulses. Static electricity can be coupled with the airframe by solid precipitation or by passage of the aircraft near an electrically charged cloud. Parasitic radioelectric signals gather on communications and navigation antennas, and can manifest in sparks, surface streamers, and coronal discharges. Coating with antistatic compounds and metallization can prevent the build-up of static charges. Lightning, however, can set off aircraft fuel, burst the radome, or kill the engines. Protective measures include isolating and/or hardening the circuitry, reducing the collector loops surface for magnetic flux with twisted wires, and by replacing conductor data wiring by optoelectronic devices such as optic fibers. M.S.K.

**A83-48218\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**ANALYSIS OF GENERAL AVIATION ACCIDENTS USING ATC RADAR RECORDS**

R. C. WINGROVE and R. E. BACH, JR. (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 20, Oct. 1983, p. 872-876. refs

Previously cited in issue 19, p. 2973, Accession no. A82-39091

**A83-48327#****CHALLENGES FOR MILITARY AIRLIFT IN THE 1990'S**

M. T. BOYCE and G. J. STRICKROTH (Boeing Military Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 8 p. (AIAA PAPER 83-2437)

A discussion is presented concerning the historical trends in military airlift requirements and the performance capabilities, including the runway length, range and payload of the airlift aircraft developed since World War II. Attention is given to the variety of Army payloads, encompassing troops, bulk cargo, oversize vehicles and outside vehicles, in relation to the payload capacity of current airlift aircraft types and numbers, to determine the combat intertheater and intratheater capability requirements and shortfalls. Special capability shortfalls are noted in the intratheater transport field, due in part to the failure of U.S. Air Force aircraft operators and U.S. Army aircraft users to arrive at common airlift aircraft design objectives, the compromise of designs in order to accommodate intertheater capabilities, and a lack of technological breakthroughs which might program costs. O.C.

**A83-48354#****AIRLINE REQUIREMENTS FOR FUTURE CIVIL TRANSPORT AIRCRAFT**

L. DI GIORGIO (Alitalia - Linee Aeree Italiane, Rome, Italy) and P. G. PASTORE American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 9 p. (AIAA PAPER 83-2501)

A discussion is presented concerning the features desired by airlines in aircraft that are to form their near future aircraft fleets, and the conflicting interests which these features must overcome during their assessment and implementation by aircraft manufacturers. The airliner classes considered are long haul intercontinental aircraft, where a low risk policy oriented toward derivatives of existing engines and airframes appears feasible for the remainder of the decade, medium/long haul transcontinental aircraft, calling for a progressive development of new versions of current designs, and short/medium haul aircraft, in which again, derivatives appear to be feasible near future prospects. O.C.

**A83-48367#****REVIEW OF HELICOPTER ICING PROTECTION SYSTEMS**

H. J. COFFMAN, JR. (Bell Helicopter Textron, Arlington, TX) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 8 p. (AIAA PAPER 83-2529)

Model 214ST and 412 helicopters, with and without rotor icing protection, have been used in development and qualification icing tests. The present investigation is concerned with a comparison of the effects of icing cloud parameters on the two helicopters, taking into account the temperature, the liquid water content, and the droplet diameter. Attention is also given to performance degradation as a function of blade chord and the benefits of aerodynamic heating. It is found that the spanwise blade deicing heater elements used on the 214ST and 412 helicopters remove effectively blade ice with a minimum of vibration and ice runback. Aerodynamic heating of the main rotor blades is a usable device for icing protection at temperatures in the range from 0 to approximately -10 C. G.R.

**A83-48885****ULTRALIGHT AIRCRAFT SAFETY AND REGULATION**

H. S. MOSELEY (Oregon Health Services University; Oregon Air National Guard, Portland, OR) Aviation, Space and Environmental Medicine (ISSN 0095-0562), vol. 54, Oct. 1983, p. 944-948. refs

A discussion is presented of the evolution of ultralight aircraft regulation and the available accident information. Attention is focused on the historical development of FAA recommendations for ultralight aircraft and pilots, up to the introduction of formal FAA regulations for ultralight aircraft in October 1982.

### 03 AIR TRANSPORTATION AND SAFETY

Recommendations regarding what should be done to qualify a pilot to fly an ultralight aircraft are evaluated. It is noted that the Experimental Aircraft Association and the Ultralight Association are seeking to regulate the sport of ultralight flying and to increase its safety, while the Aircraft Owners and Pilots Association is considering plans for pilot certification and operation. It is concluded that these organizations are making significant efforts to regulate the sport of ultralight flying without the need for expanded FAA regulations. N.B.

**A83-49588#**

#### **TRANSPORT AIRCRAFT REQUIREMENTS - HOW MUCH? HOW SOON? HOW TO PAY?**

E. S. GREENSLET (Merrill-Lynch, Pierce, Fenner and Smith, Inc., New York, NY) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 31 p. (AIAA PAPER 83-2504)

An annual review of the commercial aerospace industry is conducted, taking into account the shrinking in the size of the prospective market, lower traffic growth rates for the future, the dominance of smaller types of aircraft in the sales patterns for this decade, questions regarding the approval of aircraft for over water performance, and aspects of excess capacity for the world airline fleet. Attention is also given to the issue of financing aircraft, prospects for the launch of new aircraft, predictions concerning the market share of aircraft manufacturers, a world traffic and fleet forecast, and a forecast of demand by aircraft type. Historical data on commercial aircraft production are also presented. G.R.

**A83-49593#**

#### **COMMONALITY POTENTIAL OF FUTURE PUBLIC SERVICE HELICOPTERS AND ARMY LIGHT UTILITY HELICOPTERS**

L. S. LEVINE and E. ZALESCH (United Technologie Corp., Aerocraft Div., Stratford, CT) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 12 p. refs (AIAA PAPER 83-2553)

The opportunity exists to develop a Public Service Helicopter (PSH) responsive to the needs of the user community, based on current government-sponsored helicopter programs. Qualitative requirements of PSH and Army Light Utility Helicopter (LHX) missions are compared, and found to be generally similar. Mission performance of a LHX-derived PSH aircraft is similar to desired PSH performance. Weight and cost penalties of an LHX-derived PSH aircraft (relative to an all-new PSH design) have been compared with common-program savings. The performance of an LHX-derived PSH aircraft closely matches the needs of the PSH user community, and potential program savings for such an approach far outweigh the compromises involved in applying the design to the PSH mission. Author

**A83-49722**

#### **MICROPHYSICAL INFLUENCES ON AIRCRAFT ICING**

M. K. POLITOVICH (Wyoming University, Laramie, WY) IN: Conference on Cloud Physics, Chicago, IL, November 15-18, 1982, Preprints. Boston, MA, American Meteorological Society, 1982, p. 420-422. Sponsorship: U.S. Department of Transportation. refs (Contract DOT-FA03-81-R-50006)

The data analyzed were gathered during the winter of 1980-81 in a series of flights over the Great Lakes and Great Plains. It is found that the size, rather than the number, of cloud droplets is of prime importance in determining icing rates. This is shown by the poor correlation between icing rate and droplet concentration and the fair to good correlations between the icing rate and the droplet size or liquid water content. Icing rates for clear icing cases are found to be more predictable than for rime icing cases. C.R.

**N83-34920#** Federal Aviation Administration, Atlantic City, N.J. Technical Center.

#### **SURVEY OF CHARACTERISTICS OF NEAR MID-AIR COLLISIONS INVOLVING HELICOPTERS Final Report**

B. R. BILLMANN May 1983 25 p refs

(Contract FAA PROJ. 052-244-340)

(FAA-CT-83-40) Avail: NTIS HC A02/MF A01

Environmental conditions and operational characteristics of near mid-air collision situations involving rotorcraft were analyzed. The analysis is intended to provide data in establishing preliminary human factors and procedural design requirements for a rotorcraft collision avoidance system. Author

**N83-34921\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

#### **CRASH TESTS OF THREE IDENTICAL LOW-WING SINGLE-ENGINE AIRPLANE**

C. B. CASTLE and E. ALFARO-BOU Sep. 1983 39 p refs

(NASA-TP-2190; L-15601; NAS 1.60:2190) Avail: NTIS HC

A03/MF A01 CSCL 01C

Three identical four place, low wing single engine airplane specimens with nominal masses of 1043 kg were crash tested under controlled free flight conditions. The tests were conducted at the same nominal velocity of 25 m/sec along the flight path. Two airplanes were crashed on a concrete surface (at 10 and 30 deg pitch angles), and one was crashed on soil (at a -30 deg pitch angle). The three tests revealed that the specimen in the -30 deg test on soil sustained massive structural damage in the engine compartment and fire wall. Also, the highest longitudinal cabin floor accelerations occurred in this test. Severe damage, but of lesser magnitude, occurred in the -30 deg test on concrete. The highest normal cabin floor accelerations occurred in this test. The least structural damage and lowest accelerations occurred in the 10 deg test on concrete. S.L.

**N83-34922#** National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation.

#### **AIRCRAFT ACCIDENT REPORT: COIN ACCEPTORS, INC., CESSNA MODEL 551, CITATION 2, N2CA, MOUNTAIN VIEW, MISSOURI, NOVEMBER 18, 1982**

19 Jul. 1983 30 p refs

(PB83-910404; NTSB-AAR-83-04) Avail: NTIS HC A03/MF A01 CSCL 01C

At 0930, on November 18, 1982, a Cessna Model 551, Citation 2, N2CA, with a pilot and two passengers on board, crashed immediately after takeoff from runway 28 at Mountain View Airport, Mountain View, Missouri. The pilot and both passengers were killed. The airplane was destroyed by the crash and the postcrash fire. At the time of the accident, the weather at the Mountain View Airport was a ceiling of about 100 feet, with visibility about 1 mile in fog. The pilot had requested an IFR clearance, valid until 0930, from air traffic control. He arrived at the airport between 0920 and 0925. He boarded his passengers, loaded the baggage, and started both engines. According to witnesses, the takeoff was started about 2 minutes after the second engine was started. The takeoff appeared to be normal; however, the airplane crashed less than 3 minutes later, 1.75 miles due north of the airport. There were no witnesses to the accident. The National Transportation Safety Board determines that the probable cause of the accident was the loss of control of the airplane following the takeoff in instrument meteorological conditions as a result of the pilot's use of attitude and heading instruments which had not become operationally usable and/or his partial reliance on the copilot's flight instruments which resulted in an abnormal instrument scan pattern leading to the pilot's disorientation. Contributing to the accident was the pilot's hurried and inadequate preflight procedures. Author

**N83-34923\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**THE NASA AVIATION SAFETY REPORTING SYSTEM**

Oct. 1983 40 p refs Prepared in cooperation with Battelle Columbus Labs., Mountain view, Calif.

(NASA-TM-84339; NAS 1.15:84339; REPT-14) Avail: NTIS HC A03/MF A01 CSCL 01C

This is the fourteenth in a series of reports based on safety-related incidents submitted to the NASA Aviation Safety Reporting System by pilots, controllers, and, occasionally, other participants in the National Aviation System (refs. 1-13). ASRS operates under a memorandum of agreement between the National Aviation and Space Administration and the Federal Aviation Administration. The report contains, first, a special study prepared by the ASRS Office Staff, of pilot- and controller-submitted reports related to the perceived operation of the ATC system since the 1981 walkout of the controllers' labor organization. Next is a research paper analyzing incidents occurring while single-pilot crews were conducting IFR flights. A third section presents a selection of Alert Bulletins issued by ASRS, with the responses they have elicited from FAA and others concerned. Finally, the report contains a list of publications produced by ASRS with instructions for obtaining them. Author

**N83-34924#** Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Tech. Directorate.

**AIRCRAFT ACCELERATION SENSITIVE INERTIA REEL LOCK**

T. J. ZENOBI 15 Dec. 1982 10 p

(AD-A126739; NADC-82249-60) Avail: NTIS HC A02/MF A01 CSCL 13C

An aircraft acceleration sensitive inertial reel lock for crewmember positioning and restraint during eyeballs out (-gx) accelerations such as during an aircraft flat spin was tested. The design is simple and retrofittable to many ejection seats. Centrifuge tests indicate the locking device performs effectively and reliably. GRA

**N83-34926#** Sandia Labs., Albuquerque, N. Mex.

**PERFORMANCE OF THE SANDIA LIGHTNING SIMULATOR DURING F-14A AND F/A-18 AIRCRAFT LIGHTNING TESTS**

R. I. EWING 1983 13 p refs Presented at Intern. Conf. on Lightning and Static Elec., Fort Worth, Tex., 21 Jun. 1983 (Contract DE-AC04-76DP-00789)

(DE83-009288; SAND-83-0816C; CONF-830618-1) Avail: NTIS HC A02/MF A01

Two Navy Aircraft were subjected to high level lightning tests by using a lightning simulator. The peak pulse currents applied were varied from 9 to 170 kiloamperes. The nominal rise time to peak was 2 microseconds. Double pulses and continuing currents were applied. Several high current, high voltage pulses were also obtained. Ninety six test pulses were applied to the F-14A and 64 pulses were applied to the F/A-18. Approximately 80% of these pulses met the test specifications and essentially all pulses produced useful data. DOE

**N83-34927#** National Bureau of Standards, Washington, D.C. National Engineering Lab.

**ASSESSMENT OF CORRELATIONS BETWEEN LABORATORY AND FULL-SCALE EXPERIMENTS FOR THE FAA (FEDERAL AVIATION ADMINISTRATION) AIRCRAFT FIRE SAFETY PROGRAM. PART 6: REDUCED-SCALE MODELING OF COMPARTMENTS AT ATMOSPHERE PRESSURE**

W. J. PARKER Mar. 1983 61 p refs Sponsored by Federal Aviation Administration

(PB83-193052; NBSIR-82-2598-PT-6; FAA-CT-82-160-PT-6)

Avail: NTIS HC A04/MF A01 CSCL 01C

The temperatures, heat fluxes, air velocities, and times to flashover were compared between a number of full and reduced scale room fire tests. The model tests were usually similar but somewhat less severe than their full scale counterparts. A simplified analysis is presented to account for the lower temperatures observed in the models. Some recommendations are made with regard to physical modeling of the aircraft postcrash fires. GRA

**N83-36010#** Douglas Aircraft Co., Inc., Long Beach, Calif.

**IMPROVED INTERIOR EMERGENCY LIGHTING STUDY Final Report, 30 Sep. 1982 - 31 May 1983**

M. TEAL, A. A. AMSTER, W. H. SHOOK, and M. M. PLATTE Atlantic City, N.J. FAA Sep. 1983 76 p refs

(Contract DTFA03-82-C-00055)

(DOT/FAA/CT-83/31; MDC-J9838) Avail: NTIS HC A05/MF A01

This is the final report on the Improved Interior Emergency Lighting Study. The purpose of this study was to formulate a detailed cost analysis of two emergency light and emergency exit sign concepts or systems in commercial transport aircraft for improved passenger evacuation in dense cabin smoke conditions. Eleven emergency lighting systems were initially identified as possible candidate concepts. Of these, two were selected for a detailed cost analysis. Both selected systems are proposed as supplements to the existing emergency lighting system. Cost estimates were prepared to implement these two concepts production of new aircraft or during retrofit of existing aircraft. These estimates are summarized. B.W.

**N83-36011#** Federal Aviation Administration, Washington, D.C.

**ADVISORY CIRCULAR. CERTIFICATION OF TRANSPORT CATEGORY ROTORCRAFT**

25 Oct. 1983 267 p

(FAA-AC-29-2) Avail: NTIS HC A12/MF A01

This circular covers FAA policy on methods of compliance with Part 29 of Subchapter C, Chapter 1, Title 14 of the Code of Federal Regulations, which contains the Airworthiness Standards for Transport Category Rotorcraft. Included are methods of compliance in the areas of basic design, ground tests, and flight tests. Based largely on precedents set during helicopter certification programs spanning the past 25 years. Policy contained in earlier correspondence among FAA Headquarters, the rotorcraft industry, and certifying regions was consolidated. Author

**N83-36012#** Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.

**DEVELOPMENT OF A CONTINUOUS MODE SEQUENCING CONCEPT FOR EJECTION SEATS Final Report**

L. A. DAULERIO Jan. 1983 21 p

(Contract WF41400000)

(AD-A128966; NADC-83039-60) Avail: NTIS HC A02/MF A01 CSCL 01C

The need to provide safe egress from aircraft during low altitude, high speed and adverse attitude ejections requires the development of highly sophisticated and complex escape systems. Traditionally, the operation of an ejection seat has relied on the functioning of pyrotechnic and mechanical devices which are activated based almost exclusively on timing considerations alone, with little or no inputs from actual environmental conditions. In order to provide greater ejection seat performance it is desirable to activate these devices based on accurate and comprehensive environmental data. This report presents an ejection seat event sequencing concept whereby seat subsystems are activated and deployed based on a detailed analysis of airspeed and altitude at the time of ejection. The analysis of this concept and the results of a computer study undertaken to estimate the possible performance improvements offered by this concept will also be presented. GRA

**N83-36013#** Federal Aviation Administration, Washington, D.C. Office of Civil Aviation Security.

**THE EFFECTIVENESS OF THE CIVIL AVIATION SECURITY PROGRAM Semiannual Report, 1 Jul. - 31 Dec. 1982**

7 Apr. 1983 45 p

(AD-A128687; DOT/FAA/ACS-82-17) Avail: NTIS HC A03/MF A01 CSCL 01B

The report includes an analysis of the current threat against civil aviation along with information regarding hijacking attempts, security incidents, bomb threats, and passenger screening activity. It also summarizes ongoing activities to assure adequate protection of civil air commerce against hijacking/sabotage and related crimes, and other aspects of the Civil Aviation Security Program. GRA

## 03 AIR TRANSPORTATION AND SAFETY

**N83-36014#** McDonnell Aircraft Co., St. Louis, Mo.  
**LIGHTNING TESTS ON THE WC-130 RESEARCH AIRCRAFT**  
**Final Report, Oct. 1981 - Sep. 1982**  
W. G. BUTTERS and K. S. ZEISEL Wright-Patterson AFB, Ohio  
AFWAL Dec. 1982 43 p refs  
(Contract F33615-80-C-3406)  
(AD-A129141; AFWAL-TR-82-3093) Avail: NTIS HC A03/MF  
A01 CSCL 01C

Lightning simulation ground tests were conducted on a WC-130 aircraft which had previously been used by the Air Force in a lightning characterization program to investigate the electromagnetic field environment experienced by aircraft near active thunderstorms. Two types of lightning simulation tests were conducted. One technique used a Marx generator connected directly to the aircraft as the system stimulus. The second technique used the generator to abruptly charge a long horizontal wire which radiates the isolated aircraft with an electromagnetic pulse. Induced voltages on two interior wire pair circuits were measured. GRA

**N83-36015#** Federal Aviation Agency, Atlantic City, N.J.  
**GENERAL AVIATION SAFETY RESEARCH ISSUES Final Report**  
R. J. ONTIVEROS Jun. 1983 39 p refs  
(AD-A130074; FAA-CT-83-6; LPN-FAA-184-341-500) Avail:  
NTIS HC A03/MF A01 CSCL 01B

This report is a compilation of general aviation safety research issues extracted and summarized from recent studies conducted by the Federal Aviation Administration (FAA), other government agencies, and the aviation industry. It offers an overview of conclusions and recommendations that highlight current and future problem areas in general aviation. The report addresses the expressed needs as defined by these studies which counsel research and development relevant to the interrelationships of man, machine, and environment to effectively improve the general aviation safety record. GRA

## 04

### AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

**A83-47188#**  
**A NEW GENERATION OF NAVIGATION AND LANDING AIDS FOR AVIATION [EINE NEUE GENERATION VON NAVIGATIONS- UND LANDEHILFEN FUER DIE LUFTFAHRT]**

H. KLEIBER (Standard Elektrik Lorenz AG, Stuttgart, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 19 p. In German.

Current VOR, DVOR, and ILS electronic instrumentation is characterized, with a focus on the NAVAIDS 4000 series of ground equipment. The operating principles and specifications of the systems are reviewed, and improvements introduced in the new generations of transmitters, course antennas, and VOR/DVOR antennas are summarized. The 4000 system uses digital quartz-stabilized modulation and microprocessor control of signal errors; the functional and mechanical structure of the system components is described and illustrated, and the built-in maintenance features are discussed. It is predicted that the new generation of ILS components will serve adequately during the several decades of transition of MLS. T.K.

**A83-47193#**  
**CENTRAL OPERATING AND DISPLAY UNIT FOR AVIONICS SYSTEMS [ZENTRALE BEDIEN- UND ANZEIGEEINHEIT FUER AVIONIKSYSTEME]**

H. VIERBACHER (Rohde und Schwarz, Munich, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 11 p. In German.

The design of a compact avionics console (comprising an LED display and input keyboard for multiple functions, component interfaces, a 48-kByte program memory, and a 4-kByte memory protected against power loss) is presented. The prototype unit designed for a helicopter cockpit allows interaction with two voice-communication channels, two navigation receivers, a DME unit, an ATC transponder, and an ADF radio compass. Average power requirements are about 25 W at 28 V. The compactness of the unit (146 x 171.45 x 165 mm, 3.5 kg) and its flexibility are seen as primary advantages. Pilot and copilot units can serve complementary functions in normal operation and fulfill emergency redundancy requirements as well. T.K.

**A83-47199#**  
**DAS, A DME-SUPPORTED MULTIFUNCTION SYSTEM WITH A WIDE APPLICATIONS RANGE FOR DISTANCE AND ANGLE MEASUREMENTS WITH DATA TRANSFER [DAS, EIN DME-GESTUETZTES BREIT NUTZBARES MULTIFUNKTIONSSYSTEM ZUR ENTFERNUNGS- UND WINKELBESTIMMUNG MIT DATENUEBERTRAGUNG]**

H. ECKLUNDT (Standard Elektrik Lorenz AG, Stuttgart, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 18 p. In German.

DAS represents an extension of the DME procedure which, in the form of a new version with an enhanced location-determining accuracy, is a component of the new microwave landing system (MLS). This precision-DME has now been internationally standardized under the name 'DME/P'. The system concept DAS includes, as system components, the DME transponder, the azimuth direction finder, the DAS airborne equipment, and the DME transmission line. The results obtained in the development work are discussed, taking into account the DAS azimuth, the DME/P, and the three-way-DME. G.R.

**A83-47200#**  
**AIR TRAFFIC CONTROL SIMULATION IN THE AIRPORT AREA [FLUGSICHERUNGSSIMULATION IM FLUGHAFENNAHBEREICH]**

M. FRICKE and A. HOERMANN (Berlin, Technische Universitaet, Berlin, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 61 p. In German. refs

A Monte Carlo simulation and a dynamic simulation are used to study path maintenance accuracy for individual aircraft and the behavior of individual aircraft as elements in overall traffic. The Monte Carlo simulation is applied to examine the influence of navigational errors and of other errors on delivery time accuracy at a gate and to define accuracy requirements for future navigation systems. The dynamic simulation examines aircraft dynamics within the context of total traffic in the airport area in order to analyze the practicability of automated procedures based on air-to-ground responsibility and to compare various types of procedures. The theoretical bases of these simulations are also discussed, as are sources of error and correction mechanism. C.D.

**A83-47655**  
**IMPROVEMENTS IN SSR**

T. FORD Aircraft Engineering (ISSN 0002-2667), vol. 55, Aug. 1983, p. 11-13.

Equipment features and the performance of current secondary surveillance radars (SSR), which furnish ATCs with the aircraft identity, range, azimuth, and height are described. A rotating



directional antenna is employed to transmit a signal at 1030 MHz to aircraft equipped with transponders, which reply at 1090 MHz. The reply and initial signals are coded to interrogate identity and attitude. Jitter phenomena of the signal can result in erroneous identification of the aircraft path, while 'fruit' interference occurs when the aircraft transponder replies to interrogations of an SSR at a location other than the goal. A monopulse technique, involving two signal receivers at the ground station, is being introduced to enhance the azimuthal data accuracy. A Mode S system, involving an address selective system, is being implemented to identify specific aircraft and discern closely emitted signals from two aircraft from one another. M.S.K.

#### A83-48335#

##### AVIONICS FAULT TREE ANALYZER

L. S. COOPER (McDonnell Aircraft Co., St. Louis, MO) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 6 p. (AIAA PAPER 83-2452)

According to the existing basic maintenance concept, avionics system malfunctions are isolated down to a faulty 'black box' type Weapons Replaceable Assembly (WRA). The faulty WRA is replaced with a serviceable WRA, and the faulty WRA is forwarded to the appropriate local avionics repair facility. The Avionics Fault Tree Analyzer (AFTA) is a lightweight (85 pounds), portable test set consisting of a microprocessor controlled general purpose stored program computer, a keyboard and a plasma display, and a digital data recording set which includes three removable magnetic tape cassette cartridges. The AFTA is connected to the aircraft MUX BUS and to aircraft power. Once the diagnostic program is initiated for a particular WRA, the test time is typically of the order of milliseconds or seconds, after which the fault diagnosis appears on the display. A hard copy may also be obtained. G.R.

#### A83-48643

##### PAVE PILLAR - A NEW ROAD TO AVIONICS RELIABILITY

D. BOYLE Interavia (ISSN 0020-5168), vol. 38, Sept. 1983, p. 978-980.

The U.S. Defense Department's PAVE PILLAR program is discussed. It will replace black box avionics with a new, reconfigurable avionics architecture in which separate modules fulfill a part of the overall avionics task, providing functions which can then be allocated where they are needed, depending on the stage reached in a particular mission. The program is divided into two main parts, one of which (ICNIA) converts radio waves into useful data in the aircraft and also performs the opposite function, and the other of which (ASA) is intended to improve the internal electronic equipment of the aircraft. The architecture and redundancy of the ICNIA concept are described, and the reliability of the PAVE PILLAR program is addressed. Advances made in the ASA program, which is not as developed as ICNIA, are briefly considered. C.D.

#### A83-48733

##### PRINCIPLES AND PRESENT STATUS

G. E. COOK (Royal Aircraft Establishment, Farnborough, Hants., England) Journal of Navigation (ISSN 0020-3009), vol. 36, Sept. 1983, p. 341-360. refs

The Navstar Global Positioning System (GPS), which is a satellite-based passive radio-navigation system under development by the U.S. Department of Defense, is to be operationally deployed in the late 1980s. Each satellite is to transmit L-band spread-spectrum signals whose carrier frequencies and code epochs are synchronized with an atomic frequency standard carried by the satellite. By measuring the arrival time and frequency of the signals from at least four satellites, a user can obtain accurate three-dimensional position and velocity information. Attention is given to the evolution of the system, system description, navigation signals, receiver design, system accuracy, receiver integration with other sensors, and present status. G.R.

#### A83-48734

##### GPS FOR MARINE NAVIGATION

R. MAYBOURN (BP Shipping, Ltd., England) Journal of Navigation (ISSN 0020-3009), vol. 36, Sept. 1983, p. 355-358.

With the aid of the information provided by the Navstar Global Positioning System (GPS), it will be possible for a commercial vessel on the sea to determine its position with a high degree of accuracy. This possibility could have a great importance for commercial shipping, and automatic navigation appears to be feasible. There is, however, a major problem. For military purposes, the accuracy of the information transmitted to commercial users will be degraded. The value of GPS for commercial shipping under conditions of a degraded accuracy is discussed, taking into account also the advantages which would arise if the full capacity of GPS would become available to nonmilitary users in the not too distant future. G.R.

#### A83-48735

##### INTEGRATED NAVIGATION SYSTEMS FOR AIRCRAFT

R. F. STOKES and S. G. SMITH (Royal Aircraft Establishment, Farnborough, Hants., England) Journal of Navigation (ISSN 0020-3009), vol. 36, Sept. 1983, p. 359-378.

Work on integrated navigation for aircraft began in the UK in the mid-1950s in connection with the development of the Inertial Navigator (IN) for a guided bomb. Through the late 1960s and 1970s UK IN systems for Harrier, Phantom, Tornado, and Jaguar were developed. The most exacting requirements with respect to accuracy had to be satisfied when inertial navigation systems for maritime patrol aircraft were developed in the late 1970s. Attention is given to Kalman filtering, the form of the developed integrated navigation system, reference data, off-line processing, reference system accuracy, a possible navigation system for a maritime patrol aircraft, and the lessons learned from the integrated navigation work. G.R.

#### A83-48769

##### MISSILE GUIDANCE ELECTROMAGNETIC SENSORS

R. A. SPARKS (Raytheon Co., Missile Systems Div., Bedford, MA) Microwave Journal (ISSN 0026-2897), vol. 26, Sept. 1983, p. 24, 26, 28, 30, 32. refs

In the last two decades, missile guidance technology has been greatly influenced by the discoveries and developments in solid-state electronics. The present investigation is mainly concerned with tactical guidance sensors which are designed to utilize some fractional band of the electromagnetic energy spectrum. The guidance sensor processes electromagnetic energy which may originate at the missile launch site, within the missile itself, or at the target. Attention is given to the utilization of the microwave bands in missile guidance designs, the recent appearance of millimeter-wave guidance sensors, solutions to overcome the signal/noise problem, the deployment of guided missiles utilizing the infrared and visible portions of the spectrum, criteria regarding the selection of an electromagnetic sensor, and future trends. G.R.

#### A83-48771

##### SEMI-ACTIVE RADAR GUIDANCE

A. IVANOV (Raytheon Co., Missile Systems Div., Bedford, MA) Microwave Journal (ISSN 0026-2897), vol. 26, Sept. 1983, p. 105, 106, 108 (9 ff.). refs

The most successful and widely used of the air defense missile systems have employed semiactive guidance. The present investigation is concerned with the guidance function and the system elements required for semiactive homing. Attention is given to a semiactive system overview, aspects of seeker implementation in early systems, details of seeker evolution related to the 'inverse receiver', illuminator configurations, key microwave subsystems, systems utilizing a phased array multifunction radar, aspects of mid-course guidance, the introduction of pulse compression radars, and advances possible by employing the new technologies of microwave integrated circuits and very large scale integration of digital circuits coupled with digital signal processing. G.R.

## 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

**A83-48773**

### **MM-WAVE SENSORS FOR MISSILE GUIDANCE**

C. R. SEASHORE (Honeywell Millimeter Wave Technology Center, Bloomington, MN) Microwave Journal (ISSN 0026-2897), vol. 26, Sept. 1983, p. 133-138, 140-144. refs

The present study is concerned with considerations and tradeoffs relevant to the application of mm-wave active and passive sensors to missile guidance. Unique characteristics make millimeter waves very useful for system applications involving target tracking and terminal guidance. Their interaction with natural atmospheric constituents permits a large effective RF bandwidth and a narrow antenna beamwidth associated with small diameter antennas. Information for comparing millimeter wave operation with microwave and electrooptical techniques is presented in a table. Attention is given to propagation characteristics and targets, range equations, seeker design, RF components, and the threat of countermeasures against mm-wave active and passive guidance sensors. G.R.

**A83-48891#**

### **VOICE-ACTUATED AVIONICS**

F. W. SMEAD (ITT, ITT Avionics Div., Nutley, NJ) Astronautics and Aeronautics (ISSN 0004-6213), vol. 21, Oct. 1983, p. 54-57, 63.

The benefits, as well as design and test results, of voice-actuated digital avionic functions for fighter aircraft are examined. Voice commands ease the man-machine interface problems experienced with the present myriad of avionic displays and controls. Additionally, voice command relieves the pilot of the necessity of looking down at the controls, with responses coming from voice synthesizers or HUD apparatus. Voice recognition circuitry was tested in simulators in 1981 and introduced to aircraft in 1982. A command vocabulary was defined and used in only a recognition mode at first during in-flight tests, and successful operation with an active system was accomplished in 1983. Use of the technology for map displays, helmet-mounted displays, and smart weapons control is indicated. D.H.K.

**N83-34930#** Systems Control Technology, Inc., West Palm Beach, Fla.

### **ALASKA LORAN-C FLIGHT TEST EVALUATION Final Report, Aug. - Sep. 1982**

L. D. KING and E. D. MCCONKEY Mar. 1983 105 p refs (Contract DOT-FA01-80-C-10080) (AD-A128633; FAA-PM-83-4) Avail: NTIS HC A06/MF A01 CSCL 14B

This report contains the description and results of a Loran-C flight test program conducted in the State of Alaska. The testing period was from August 1982 to September 1982. The purpose of the flight test was to identify applicable Loran-C accuracy data for the Alaskan air taxi and light aircraft operators so that a Supplemental Type Certificate (STC) can be issued in the Alaska Region for the Loran-C system tested (Teledyne TDL-711). Navigation system errors were quantified for the Loran-C unit tested. The errors were computed from knowledge of position calculated from ground truth data and the indicated position of the navigator. Signal coverage, bias and flight technical error data were also obtained. Multilateration ground truth, photographic ground truth, and data acquisition systems were carried aboard the test aircraft. The tests were concentrated in the southwest part of the Alaskan mainland. An interconnecting network of routes west of Anchorage and south of a line from Fairbanks to Kotzebue were flown for data collection. GRA

**N83-34932#** Federal Aviation Administration, Washington, D.C. Office of Systems Engineering Management.

### **SUMMARY PROCEEDINGS OF THE FUTURE NAVIGATION SYSTEMS PLANNING CONFERENCE**

Sep. 1982 93 p refs Conf. held at Washington, D.C., 3-4 Aug. 1982 (AD-A128717; DOT/FAA/EM-82/26) Avail: NTIS HC A05/MF A01 CSCL 17G

This publication contains a summary of proceedings of the Federal Aviation Administration (FAA) Future Navigation Planning

Conference held at the Federal Aviation Administration Headquarters, Washington, D.C., on August 3-4, 1982. The purpose of the conference was: (1) to present to the users and suppliers of navigation systems, the results of FAA sponsored studies and technical evaluations of navigation systems which are to satisfy air navigation requirements in the post 1995 time period; and (2) to seek industry views on several different options for future air navigation systems preparatory to the FAA developing its recommendations on policies and plans for radionavigation services. Author (GRA)

## 05

## **AIRCRAFT DESIGN, TESTING AND PERFORMANCE**

Includes aircraft simulation technology.

**A83-47192#**

### **DEVELOPMENT AND TESTING OF A HIGH-TECHNOLOGY AMPHIBIOUS FLYING VEHICLE**

G. KRIECHBAUM (Dornier GmbH, Friedrichshafen, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 42 p. In German.

The planning, implementation, and results of a project to produce a high-technology amphibious flying vehicle with outstanding high seas capability are described. The goals, requirements, development, realization, testing, and supplementary studies are outlined. The technical aspects are addressed, including configuration, aerodynamics, flight mechanics, and weight. The physical construction is described in some detail, including the wing assembly, fuselage and tail unit, chassis, drive unit, and equipment. The tests to which the vehicle was subjected are outlined. C.D.

**A83-47195#**

### **HINGELESS AND BEARINGLESS MAIN ROTOR IN A FIBER COMPOSITE TYPE OF CONSTRUCTION FOR DYNAMIC SYSTEMS OF FUTURE HELICOPTERS [GELENK- UND LAGERLOSER HAUPTROTOR IN FASERVERBUNDBAUWEISE FUER DYNAMISCHE SYSTEME ZUKUNFTIGER HUBSCHRAUBER]**

H. HUBER (Messerschmitt-Boelkow-Blohm GmbH, Unternehmensbereich Drehflueger und Verkehr, Munich, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 28 p. In German. refs

A German aerospace company is engaged in a government-sponsored program involving the development of a hingeless and bearingless main rotor for dynamic systems of helicopters. The principal objectives of this project are related to an improvement of operational efficiency, service life, and reliability, taking into account also a reduction of manufacturing and operational costs and decreasing expenditures for maintenance. The structural design is based on the employment of fiber-reinforced plastics, which provide a high elasticity combined with a low stress level and unlimited life. A main rotor experimental version was developed and built on the basis of a selected design. The results of the development work show that the concept of a bearingless main rotor can be realized on the basis of a utilization of fiber-reinforced composites. G.R.

A83-47196#

**THE SYSTEM ARIS AND ITS EMPLOYMENT IN THE DEVELOPMENT OF FUTURE HELICOPTERS [DAS SYSTEM ARIS UND SEINE ANWENDUNG BEI DER ENTWICKLUNG ZUKUNFTIGER HUBSCHRAUBER]**

D. BRAUN (Messerschmitt-Boelkow-Blohm GmbH, Unternehmensbereich Drehfluegler, Ottobrunn, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 33 p. In German. refs

One approach for the reduction of the rotor-induced cabin vibrations of a helicopter is related to the isolation of the rotor with the aid of suitable isolator elements. The present investigation is concerned with the development of a passive rotor isolation system for helicopters. The system consists essentially of five uniaxial antiresonant vibration isolators. Attention is given to details regarding the isolation system and its principles of operation, the design and efficiency of the isolator elements, ground tests conducted with the entire system, and flight test results. It is planned to offer the rotor isolation system, after further development work, as supplementary equipment for the helicopter model BK 117. G.R.

A83-47210#

**STUDIES AND DESIGNS FOR A NEW HELICOPTER COCKPIT [UNTERSUCHUNGEN UND ENTWUERFE FUER EIN NEUES HUBSCHRAUBER COCKPIT]**

R. D. VON RETH (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 41 p. In German. refs

The avionics development program being undertaken with support from the FRG Research and Technology Ministry to increase the operating range, safety, and pilot comfort of civilian helicopters is presented. Cooperation among helicopter manufacturers and electronics firms is intended to increase the market share of FRG firms in the avionics field. The systems currently being tested are characterized and illustrated, including a ground-independent navigation system (combining Doppler and strapdown systems), a multiple-purpose TV screen, windshield and helmet-mounted viewing systems, a computer symbol generator, image-intensifier eyeglasses, FLIR and LLLTV cameras, an obstacle-warning system, a centralized service unit, and a flexible operation and diagnosis system. Various control-panel and operating-control combinations were compared, and an arrangement with multiaxial side-arm control levers was found to be most comfortable by the test pilots. The helicopter simulator developed for instrument tests is described. T.K.

A83-47215#

**A JOINTLESS AND BEARINGLESS TAIL ROTOR OF FIBER-REINFORCED-COMPOSITE CONSTRUCTION [GELENK-UND LAGERLOSES HECKROTORSYSTEM IN FASERVERBUNDBAUWEISE]**

H. FROMMLET (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 31 p. In German.

The design, construction, and preliminary testing of 3 and 4-blade tail rotors (diameter = 1.95 m, maximum thrust = 4700 N) for helicopters of the 3-ton class are reported. The bearings and joints of conventional rotors are eliminated by using flexible elements of GFRP and CFRP composites, allowing a 20-percent weight saving, lower manufacture and maintenance costs, and reduced noise levels. Preliminary static and cyclic tests confirm the feasibility of the design approach. Photographs, drawings, graphs of the results, and tables comparing the performance of the 3 and 4-blade rotors with other conventional and bearingless rotors are provided. T.K.

A83-47216#

**ON-BOARD WEIGHT AND CENTER-OF-GRAVITY MEASUREMENT SYSTEM WITH TIRE-PRESSURE MONITORING [BORDSEITIGE GEWICHTS- UND SCHWERPUNKTMESSANLAGE MIT REIFENDRUCKUEBERWACHUNG]**

L. KAMRADT (VDO Luftfahrtgeraete Werk Adolf Schindling GmbH, Frankfurt am Main, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 45 p. In German.

The design and performance of a system which monitors aircraft weight, balance, and tire pressure simultaneously, using advanced shear-stress sensors mounted on the nose and main landing-gear supports, are reported and illustrated. A redundant system which employs four sensors on each landing gear assembly and is integrated with the instrument-panel display and with the ECAM and fuel-system-trimming computers has been tested operationally in a DC-10 since October, 1981, and found to give measurements accurate to within 1 percent. The device is shown to allow the elimination of the load-sheet process (thus speeding aircraft loading and dispatching) and to increase reliability by excluding human errors. T.K.

A83-47985#

**ADVANCING ELECTRONIC TECHNOLOGY IMPACT ON INTEGRATED PROPULSION/AIRFRAME CONTROLS DESIGN AND DEVELOPMENT**

J. HOUCARD, C. CARLIN, and E. TJONNELAND (Boeing Military Airplane Co., Seattle, WA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs (ASME PAPER 83-GT-161)

The design of aircraft control systems has become more difficult in connection with rising flight system performance requirements. However, current electronic technology can make a very significant contribution to the solution of the control problems. Applications of full authority digital electronic control, in conjunction with high speed serial data buses and advanced displays provide the control system designer opportunities for reducing weight and cost while increasing transient performance, system reliability, and availability. Attention is given to the design of integrated controls, analytical tools, simulation and test facilities requirements, and questions of software development. G.R.

A83-48024#

**PROPULSION SYSTEM INTEGRATION AS APPLIED TO BUSINESS JET AIRCRAFT**

J. P. SUGGS and G. W. BURLEY (Garrett Turbine Engine Co., Phoenix, AZ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 10 p. (ASME PAPER 83-GT-227)

The three major phases of the integration of an engine into a new or existing airframe are described. The first phase represents the preliminary design and involves all aspects of model testing, engine inlet compatibility, matching studies, and aircraft performance determinations necessary to assure an economically viable product. The second phase involves the detailed design of the nacelle and interface systems, as well as a mockup evaluation period during which the installation interface requirements are included. The third phase consists of ground and flight tests resulting in FAA certification, and includes the demonstration of the aircraft and propulsion system performance and compatibility. These three phases are discussed with regard to the two-, three-, and four-engine configurations used by all general aviation aircraft. B.J.

## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

**A83-48033#**

### **STOL FIGHTER TECHNOLOGY PROGRAM**

D. R. SELEGAN (USAF, Wright-Aeronautical Laboratories, Wright-Patterson AFB, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p.  
(ASME PAPER 83-GT-243)

The objectives and implementation of the STOL Technology Fighter program are examined. This multidisciplinary program will investigate various technologies both singularly and in integrated combinations in order to quantify their contribution to providing options in solving the STOL design task, including technologies such as aerodynamics, integrated controls, thrust vectoring/reversing exhaust nozzles, landing gear, and cockpit aids and controllers necessary to operate under adverse weather conditions and/or at night. The objective of the program is to develop advanced technologies applicable to providing a STOL capability for fighter aircraft without sacrificing current maneuver, cruise, and load performance. Specific technologies to be addressed in this program include two-dimensional thrust vectoring/reversing exhaust nozzle, integrated flight/propulsion control, advanced high lift systems, and rough/soft field landing gear. This program will employ either a modification of an existing fighter or a new hybrid vehicle with these technologies integrated into the vehicle. The end objective of the program is to demonstrate take offs and landings under wet runway conditions of under 1500 feet including dispersion. N.B.

**A83-48100**

### **AIRCRAFT DESIGN (3RD REVISED AND ENLARGED EDITION) [PROEKTIROVANIE SAMOLETOV /3RD REVISED AND ENLARGED EDITION/]**

S. M. EGER, V. F. MISHIN, N. K. LISEITSEV, A. A. BADIAGIN, V. E. ROTIN, F. I. SKLIANSKI, N. A. KONDRASHOV, V. A. KISELEV, and N. A. FOMIN Moscow, Izdatel'stvo Mashinostroenie, 1983, 616 p. In Russian. refs

The first of the three parts of the book is concerned with questions of general aircraft design and the characteristics of the design of aircraft for various assignments. The theoretical and methodological basis of aircraft design is considered along with the criteria and methods for an evaluation of design and construction solutions, basic design data, the selection of fundamental parameters, the analysis and selection of aircraft design characteristics and engine type, the calculation of aircraft weight, the optimization of aircraft parameters, and the positioning of the center of gravity of the aircraft. The design of individual aircraft sections is discussed in the second part of the book, taking into account general aspects of aircraft section design, the design of the wing section, the design of the fuselage, questions of engine design, empennage design, aircraft control system design, and chassis design. The third part of the book provides a description of the principles of design automation. G.R.

**A83-48213\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

### **EFFECTS OF ANGLE OF ATTACK ON TRANSONIC FLUTTER OF A SUPERCRITICAL WING**

E. C. YATES, JR., E. C. WYNNE, and M. G. FARMER (NASA, Langley Research Center, Loads and Aeroelasticity Div., Hampton, VA) (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers. Part 2, p. 122-144) Journal of Aircraft (ISSN 0021-8669), vol. 20, Oct. 1983, p. 841-847. refs

Previously cited in issue 13, p. 2021, Accession no. A82-30143

**A83-48328#**

### **DESIGN OF GLASS-FACED HELICOPTER WINDSHIELDS FOR SURVIVAL IN A PARTICLE IMPACT ENVIRONMENT**

R. R. DIGENOVA (United Technologies Corp., Sikorsky Aircraft, Stratford, CT) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 7 p. refs  
(AIAA PAPER 83-2439)

At a U.S. aerospace company, it was found that the reliability requirements for newly introduced glass-faced windshield design for helicopters could not be satisfied in service. Most windshield removals were necessary because of damage and cracking involving the outer glass face ply. However, the cause of the damage could not be explained. An investigation was initiated to determine the cause for the observed failures and to find an approach for correcting this situation. Attention is given to glass characteristics and approaches for enhancing its strength, the impact resistance, and the development of a model for predicting windshield impact performance in service. The conclusions of the investigation are discussed. G.R.

**A83-48329#**

### **APPLICATION OF COMPOSITES AND COMPUTER GRAPHICS IN THE DESIGN OF THE MH-53E FUEL SPONSON**

T. A. REILLEY and R. T. WELGE (United Technologies Corp., Sikorsky Aircraft, Stratford, CT) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 5 p.  
(AIAA PAPER 83-2441)

The MH-53E represents the Navy's minesweeping derivative of the Marine CH-53E Super Stallion. One of the factors defining the configuration of the MH-53 is related to a requirement for increased fuel capacity to extend time on station. In an investigation concerning the most suitable way to satisfy this requirement, large sponsons were found to be the optimum configuration. It was decided to use computer graphics for definition of all internal systems and all structural components. During the design process, it was recognized that substantial saving could be made by using to a greater extent composites for the primary structure. This recognition led to the nearly exclusive use of advanced composites. G.R.

**A83-48330#**

### **ADVANCED LIGHTWEIGHT, FIRE RETARDANT FLOOR PANELING FOR AIRCRAFT**

F. J. GORGES (Boeing Commercial Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 6 p.  
(AIAA PAPER 83-2442)

The basic purpose of the panels of aircraft floor systems is to form a passenger or cargo surface over the support structure and accept the normal service loads associated with passenger and cargo travel. Basic problems concerning the material to be employed for the panels are related to the development of a high strength, light-weight, fire retardant, low smoke, reduced toxicity, durable panel which utilizes an efficient sealing system for substructure corrosion protection. Advances with respect to the development of an optimum floor paneling for aircraft are discussed. Fire retardant floor paneling of lighter weight could be developed. The use of graphite face-sheets for the passenger flooring reduces the weight by 11 percent, compared to production fiberglass paneling, while the application of Kevlar and fiberglass hybrid face-sheets for cargo flooring lowered the weight by 6 percent. G.R.

**A83-48332#****LIGHT AIRCRAFT WING STRUCTURE OPTIMIZATION**

R. BOUDREAU (Sherbrooke, Université, Sherbrooke, Quebec, Canada) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 7 p. refs  
(AIAA PAPER 83-2446)

The wing that was selected for the project was a NACA 63-412. It was chosen for its low drag characteristics and its laminar plateau in its Drag Polar Curve. Structural work was started and an optimization of structure 'subcontract' was given as a course project in a conception method course. The structure chosen was a two-cell box beam. A standard approach to structural computation was made and the equations obtained for bending, torsion and shear were used in conjunction with different optimizing codes to obtain optimum structural design. A comparison of the optimizing codes followed. Author

**A83-48338#****FUTURE AIRCRAFT DEVELOPMENT FOR COMMUTER AND THIRD-LEVEL OPERATIONS**

J. E. CHACKSFIELD (British Aerospace PLC, Airframe Engineering Dept., Kingston-upon-Thames, Surrey, England) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 7 p. refs  
(AIAA PAPER 83-2464)

Regarding Commuter airlines in the U.S., current trends due to deregulation are toward an increase in the average stage length. The range potential of the ideal Commuter design requirement has, therefore, moved closer to that of the Third Level airline. Some aircraft originally designed for Third Level or STOL operations are being employed by specialized commuter operators. Particular attention is given to questions of fuel economy. Excellent fuel economy is provided by the turboprop, and especially the recent developments of this type of power plants. The introduction of advanced technology with respect to the propeller appears promising. Attention is given to propulsive efficiencies, advances related to aerodynamic improvements, the possibility of a 'quantum jump' related to composites in approximately 1995, the importance of flexibility with respect to market considerations, advances in the application of avionics, the flight deck, digital systems, and the commuter aircraft market. G.R.

**A83-48339#****A CONCEPTUAL DESIGN PROGRAM FOR EDUCATIONAL PURPOSES**

D. M. LAYTON (U.S. Naval Postgraduate School, Monterey, CA) and S. G. KEE (U.S. Army, Safety Center, Fort Rucker, AL) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 7 p. refs  
(AIAA PAPER 83-2473)

A description is given of a helicopter conceptual design course. The design is primarily concerned with the performance of the helicopter, and does not consider stability effects. The design process is enhanced through the extensive use of computer programs. Author

**A83-48344#****PERFORMANCE OF A FORWARD SWEEP WING FIGHTER UTILIZING THRUST VECTORING**

E. H. MILLER (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 12 p. refs  
(AIAA PAPER 83-2482)

The benefits of a use of nonaxisymmetric nozzles in advanced propulsion systems are related to improved installed performance, aircraft maneuverability, and STOL characteristics. Several programs sponsored by U.S. governmental agencies are concerned with the development of the technology base which is needed for a verification and quantification of analytically indicated benefits. The V/STOL nozzle program represents one of the most important

of these programs. In connection with this program, a full scale Augmented Deflector Exhaust Nozzle (ADEN) was conceived, designed, built, and tested on a YJ-101 engine. The considered investigation has the objective to determine installation feasibility for incorporation of an ADEN on the F404-F400 engine, which is installed in the X-29 Forward Swept Wing aircraft. The study results indicate the advantages of vectored thrust through the installation and integration of the ADEN into the X-29. G.R.

**A83-48347#****EFFECT OF AIRCRAFT CONFIGURATION AND CONTROL INTEGRATION ON SURFACE ACTUATION**

B. E. RABENBERG and B. G. PALARZ (Rockwell International Corp., El Segundo, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 6 p.  
(AIAA PAPER 83-2487)

Design trends for advanced fighter aircraft are resulting in new and increasingly stringent requirements for control surface actuator systems. This paper presents and discusses the aircraft configuration and control integration related requirements that are driving actuator design. Among these are relaxed static stability, supersonic maneuvering, aeroelastic tailoring, and digital fly-by-wire control. The impact of these design drivers on actuator requirements for fault tolerance, structural interfacing, stiffness, failure modes and effects, and performance is presented. A status of advanced actuator design trends and concepts for meeting these requirements is also presented and discussed. Author

**A83-48355\*#** National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

**SIMULATIONS USED IN THE DEVELOPMENT AND FLIGHT TEST OF THE HIMAT VEHICLE**

M. B. EVANS and L. J. SCHILLING (NASA, Flight Research Center, Edwards, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 14 p. refs  
(AIAA PAPER 83-2505)

Real-time simulations have been essential in the flight-test program of the highly maneuverable aircraft technology (HiMAT) remotely piloted research vehicle at the Dryden Flight Research Facility of NASA Ames Research Center. The HiMAT project makes extensive use of simulations in design, development, and qualification for flight, pilot training, and flight planning. Four distinct simulations, each with varying amounts of hardware in the loop, were developed for the HiMAT project. The use of simulations has been the key to flight qualification of the HiMAT vehicle. Specifically, they are useful in detecting anomalous behavior of the flight software and hardware at the various stages of development, verification, and validation. Author

**A83-48356\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**A FLIGHT TEST OF LAMINAR FLOW CONTROL LEADING-EDGE SYSTEMS**

M. C. FISCHER, A. S. WRIGHT, JR., and R. D. WAGNER (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 11 p. refs  
(AIAA PAPER 83-2508)

NASA's program for development of a laminar flow technology base for application to commercial transports has made significant progress since its inception in 1976. Current efforts are focused on development of practical reliable systems for the leading-edge region where the most difficult problems in applying laminar flow exist. Practical solutions to these problems will remove many concerns about the ultimate practicality of laminar flow. To address these issues, two contractors performed studies, conducted development tests, and designed and fabricated fully functional leading-edge test articles for installation on the NASA JetStar aircraft. Systems evaluation and performance testing will be conducted to thoroughly evaluate all system capabilities and

characteristics. A simulated airline service flight test program will be performed to obtain the operational sensitivity, maintenance, and reliability data needed to establish that practical solutions exist for the difficult leading-edge area of a future commercial transport employing laminar flow control. Author

**A83-48357#**  
**AERODYNAMICS PROPULSION AND LONGITUDINAL CONTROL REQUIREMENTS FOR A TILT-NACELLE V/STOL WITH CONTROL VANES SUBMERGED IN THE NACELLE SLIPSTREAM**

J. KOHN (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 11 p. (AIAA PAPER 83-2513)

A longitudinal V/STOL flight envelope of the Grumman 698 tilt-nacelle design was determined, using a computer simulation in conjunction with test and estimated data for the hover, transition and cruise modes. For the broad range of angle of attack and airspeeds examined, this design is fully controllable, employing a slab tail optionally geared to vanes submerged in the nacelle slipstream. Collective and differential power is also available for low-speed height and roll control, and high-speed acceleration. The aerodynamic and propulsion forces complement each other, resulting in smooth variation of aero control and power settings in transition while varying the airspeed. Also for the purpose of controlling attitude at a fixed airspeed, powered and aerodynamic lift may be exchanged. The aerodynamic and propulsion effects, flow field and kinematic relations were easily determined from the computer simulation graphics output. Within the simulation envelope, or up to about 200 knots, this analysis demonstrates that the airplane attitude, flight path, aerodynamic and propulsive lift can be controlled within expected operational conditions. Author

**A83-48360#**  
**DEPOT LEVEL REPAIRABILITY, MAINTAINABILITY, AND SUPPORTABILITY OF ADVANCED COMPOSITES**

W. SCHWEINBERG, P. MANNING, L. RAGAN, and T. CHRISTIAN, JR. (USAF, Warner Robins Air Logistics Center, Robins AFB, GA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 8 p. (AIAA PAPER 83-2516)

This paper discusses advanced composite materials in aircraft structure from a logistics, or depot, viewpoint. Lessons learned in major repair of damaged items, maintainability design features, and supportability are presented with the intent of assisting others in the repair function and addressing to designers steps that should be taken to greatly improve the reliability and maintainability of future designs. The need for research into quick repair methods compatible with a battlefield environment and high sortie rate requirements is discussed along with suggestions for more survivable future designs. Author

**A83-48363#**  
**FORMULATION OF A HELICOPTER PRELIMINARY DESIGN COURSE**

J. W. RUTHERFORD and J. K. STROZIER (U.S. Military Academy, West Point, NY) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 7 p. refs (AIAA PAPER 83-2521)

Since the mid-1970s, the cadets at the U.S. Military Academy can concentrate their elective courses in aerospace engineering. A helicopter design course is a required course for all students who select the aerospace-systems option of the Accreditation Board for Engineering and Technology (ABET) mechanical engineering major. The title of the course is 'Aerospace Systems Design'. Attention is given to a course overview, aspects of main-rotor design, fuselage design, tail-rotor design, the use of computers during the course, and details concerning the final report.

The course is intended to sharpen the students' skills and to enlarge their knowledge of rotary-wing aircraft. G.R.

**A83-48364\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.  
**OPERATIONAL MILITARY HELICOPTER INTERIOR NOISE AND VIBRATION MEASUREMENTS WITH COMPARISONS TO RIDE QUALITY CRITERIA**

S. A. CLEVENSON, J. D. LEATHERWOOD (NASA, Langley Research Center, Hampton, VA), and D. D. HOLLENBAUGH (U.S. Army, Applied Technology Laboratory, Fort Eustis, VA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 11 p. refs

(AIAA PAPER 83-2526)

Balka (1981) has identified the attainment of a 'jet-smooth' ride as a primary goal of the helicopter industry for commercial and certain military helicopters. It was noted that criteria accounting for both multiple axis vibration and interior noise are needed. The present investigation has the objective to present a vibration and interior noise data base in a format suitable for direct evaluation of aircraft ride quality. The investigation is also concerned with an assessment of the measured environment against available criteria as an indication of the state-of-the-art for current machines. Interior noise and vibration measurements were obtained on eight military helicopters during routine operational flights. The data are presented in the form of a number of parameters. G.R.

**A83-48365#**  
**NOTAR - THE VIABLE ALTERNATIVE TO A TAIL ROTOR**

E. P. SAMPATACOS, K. M. MORGER, and A. H. LOGAN (Hughes Helicopters, Inc., Culver City, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 9 p. refs (AIAA PAPER 83-2527)

A single rotor helicopter directional control system utilizing an enclosed fan has been developed by an American aerospace company. The NO Tail Rotor (NOTAR) system consists of a variable pitch fan, a circulation control tail boom, a valved turning vane array ('direct jet thruster'), and a vertical fin. It is pointed out that the NOTAR system separates the yaw moment required to trim the main rotor torque from the yaw moments the pilot uses to maneuver the aircraft. For a NOTAR technology demonstration, the tail rotor in a helicopter was replaced with the NOTAR system for ground and flight tests. The demonstration proved that the NOTAR system is a viable alternative to a tail rotor for single main rotor helicopters. It is found that the NOTAR system is inherently safer than a tail rotor helicopter. G.R.

**A83-48366#**  
**DESIGN AND TECHNOLOGY INFLUENCES - 'MATURITY' AT INTRODUCTION OF THE 214ST**

D. A. FORD (Bell Helicopter Textron, Customer Support and Service Div., Fort Worth, TX) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 6 p. (AIAA PAPER 83-2528)

A vital factor in connection with the introduction of a new aircraft model is related to the tradeoff between the benefits offered by new technology and the impact on the operator as the model matures. As measured by the commercial operator, the key elements of maturity include the safety record, the dispatch reliability, in-service availability, economics of operation, and passenger acceptance. The Model 214ST Supertransport has included from its very inception the considered elements as key design objectives. Attention is given to the definition of design parameters, the key design decisions, the maximization of the redundancy of required systems, details regarding a design for maintainability, and efforts directed toward a minimization of the direct operating costs. G.R.



A83-48369#

**STOL ATTACK AIRCRAFT DESIGN BASED ON AN UPPER SURFACE BLOWING CONCEPT**

R. D. KIMBERLIN and A. K. SINHA (Tennessee, University, Tullahoma, TN) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 8 p. refs  
(AIAA PAPER 83-2535)

The conceptual design of an upper surface blown (USB) aircraft for low level attack missions is proposed. The design calls for the by-pass air of a single turbofan engine to be ducted through and blown over the wing upper surface and the hot core exhaust ducted out of a conventional tail pipe fitted with an afterburner. The proposed aircraft would be capable of achieving moderate supersonic speed. The proposed aircraft shows a significant gain in maneuver performance as well as range-payload and short field capability when compared with a conventional aircraft of the same class. Author

A83-48370#

**SUBSONIC AIRPLANE CONFIGURATIONS FOR MAXIMUM RANGE FOR ENDURANCE**

T. S. SCHREIBER American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 5 p.  
(AIAA PAPER 83-2536)

After considering a family of aircraft of a specified gross weight and usable interior volume, which are apportioned between the wing and fuselage, the apportionment of usable volume between the wing and fuselage is determined so as to maximize range or endurance for propeller driven and jet propelled aircraft flying at subsonic speeds. The analysis indicates that, for propeller aircraft, a flying wing configuration optimally maximizes range and endurance, while in the case of jet aircraft this configuration maximizes endurance. For aerodynamic and geometric design values characteristic of modern design practices, a wing-body jet propelled configuration is optimal and provides substantially greater range than the flying wing. O.C.

A83-48375\*# Texas A&amp;M Univ., College Station.

**WING EXTENSIONS FOR IMPROVING CLIMB PERFORMANCE**

O. W. NICKS (Texas A&M University, College Station, TX) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 8 p. refs  
(Contract NAG1-184)  
(AIAA PAPER 83-2556)

Recent wind tunnel studies have shown that significant improvements in wing efficiency and climb performance can be achieved using wing extensions having sharp edges and unmodified upper airfoil contours. Based on tests of six configurations, a simple tip shape provided the best wing efficiency at high lift conditions without penalty during cruise conditions. The best configuration tested exhibited more than 20 percent improvement in the maximum rate of climb, plus a reduction in stall speed and a slight improvement in cruise performance over a baseline tip with a round edge. In addition to measurements that were used to determine performance, flow visualization studies provided insight into reasons for improved wing efficiency. Tests were conducted using a high performance general aviation aircraft model with a tapered, cantilevered wing. Author

A83-48376#

**EFFICIENT COMPUTATIONAL GRID GENERATION FOR THREE-DIMENSIONAL AIRCRAFT CONFIGURATIONS**

D. M. SOMMERFIELD, S. R. KENNON, and G. S. DULKRAVICH (Texas, University, Austin, TX) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 7 p.  
(AIAA PAPER 83-2557)

A fast computer code (WING3D) has been developed to generate three-dimensional, C-type, boundary conforming, quasi-orthogonal grids for realistic wing-canard fuselage or

wing-tail-fuselage combinations. The grid generation technique is based on simple analytic functions for the conformal mapping transformation, thus making the grid generation fast and accurate. Grid nonorthogonality is introduced by analytic coordinate shearing and stretching transformations. The grids can be easily clustered closer to the wing surface, the trailing and leading edges, or the fuselage surface. Elliptic cutting surfaces are used to divide the three-dimensional space into a series of elliptic surfaces. These surfaces, containing intersection contours of the wing and canard (or tail) are transformed into a series of two-dimensional planes. In each plane, two separate grids are developed for each intersection contour and then joined together along a common boundary. Each two-dimensional grid is then transformed back into three-dimensional space to form the final grid. Author

A83-48377#

**VON MISES WING OPTIMIZATION**

R. BOUDREAU (Sherbrooke, University, Sherbrooke, Quebec, Canada) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 5 p. refs  
(AIAA PAPER 83-2558)

Work leading to the development of an optimal light-aircraft airfoil (general aviation) is presented. The airflow model is based on a potential flow conformal mapping simulation. The optimization is worked out through a numerical optimizer program. Two different methods of numerical optimization are used and compared. An example of the resulting wings is presented and compared to NASA GA(w)-2 high lift airfoils. Comparison of the Von Mises optimum and of the GA(w)-2 wings shows a finesse advantage of about 10 percent to the Von Mises optimum wing benefit. Author

A83-48641

**PAH-2, HAP, HAC - WILL THEY REALLY GET UNDER WAY THIS TIME?**

M. LAMBERT Interavia (ISSN 0020-5168), vol. 38, Sept. 1983, p. 961-964.

Plans for the Franco-German armed helicopter are discussed. The aims of each government, often divergent, for various helicopter systems and components are described, along with the projected costs of these elements. The configurations of the airframe and rotor system are considered, as is the choice of European or American avionics. The planned helicopter's armaments, powerplant, and flight controls are discussed. C.D.

A83-48642

**LHX - THE US ARMY WANTS 5,000 - INDUSTRY NEEDS THE BUSINESS**

R. LOPEZ and M. LAMBERT Interavia (ISSN 0020-5168), vol. 38, Sept. 1983, p. 972-974.

Progress in planning for the U.S. Army LHX helicopter is discussed. The missions of the proposed helicopter, including troop transport, combat, and surveillance, are addressed, and the number of LHX's required is discussed in the light of the Army's helicopter needs. The timetable for LHX production is set forth, and the Army's Advanced Rotorcraft Technology Integration (ARTI) demonstration, planned as a prologue to an LHX competition between two contractors, is discussed. ARTI will blend promising airframe, system, and engine technologies in a technology demonstrator, probably a helicopter. The industry's response to the LHX plans is described, mentioning each company's suggestions and the extent of its need for the LHX contract. C.D.

A83-48887#

**BUCKING THE CURRENT**

B. FRISCH Astronautics and Aeronautics (ISSN 0004-6213), vol. 21, Oct. 1983, p. 28-31.

The development and testing of designs of electric actuators for V/STOL aircraft are described. A worst-case scenario, i.g., Mach 1.2 attack through thunderstorm turbulence followed by a 45 sec, 360 deg, 8 g turn, was analyzed to set the design criteria.

## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Candidate motors producing 5, 10, and 15 hp were subjected to temperature tests up to 500 F to assay the windings' capabilities to dissipate heat, which is a greater problem with electric than hydraulic actuators. The turbulence bandwidth tolerances required led to a design of four 8-pole motors with a gear ratio of 850:1. A second design, for a hinge-line electromechanical actuator, is being tested for the F-14 rudders. Work remains to be done in terms of reducing the actuator weight, perfecting the inverters, and eliminating overheating. D.H.K.

### A83-49183

#### EXPERIENCE FROM FLIGHT FLUTTER TESTING WITH TIP VANES ON AIRBUS

K. KOENIG (Vereinigte Flugtechnische Werke, Bremen, West Germany) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 130-142.

For the flight vibration tests on the Airbus A310, an excitation system had to be developed. In order to determine optimal system characteristics, an investigation was conducted and several alternatives were considered. As a result of this investigation a tip vane excitation system was developed for the tests. The selected system was found to be very effective, and it was possible to excite 11 vibration modes within the examined frequency range. Attention is given to the design of the excitation system, the development tests, the flight tests and the measuring results, and the result of the modal analysis. G.R.

### A83-49187

#### IDENTIFICATION AND CONTROL OF FLUTTER ON MILITARY COMBAT AIRCRAFT

C. G. LODGE (British Aerospace PLC, Aircraft Group, Preston, Lancs., England) and J. C. A. BALDOCK (Royal Aircraft Establishment, Farnborough, Hants., England) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 169-178.

It is pointed out that modern flutter prediction methods remain largely empirical, in spite of the powerful theoretical techniques available. Flutter of the complete aircraft is considered, taking into account the representation of the flutter conditions found in binary form which can then be interpreted economically and rapidly with the aid of graphical procedures. Some typical results of fixed-root and complete aircraft flutter calculations are presented. Attention is given to the fixed root fin, the fixed root taileron, the antisymmetric aircraft, the handling of nonlinearities in flutter calculations, and the prospects for active control. G.R.

### A83-49189

#### AEROELASTIC CONSIDERATIONS FOR AUTOMATIC STRUCTURAL DESIGN PROCEDURES

G. SCHNEIDER and H. GOEDEL (Messerschmitt Boelkow-Blohm GmbH, Munich, West Germany) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 196-207. refs

A number of automated methods have been developed for the analysis of airframe structures, taking into account strength characteristics and aeroelastic behavior. The present investigation is concerned with the utilization of automatic structural design procedures in the design of highly maneuverable fighter aircraft. It is pointed out that the primary objective of new fighter aircraft studies is to improve transonic and supersonic performance. New aircraft design concepts are discussed along with automatic structural design procedures, and aeroelastic considerations. Attention is given to the aerodynamic mathematical model, a structural mathematical model, control surface effectiveness, an advanced wing design study, and effective flap size. G.R.

### A83-49190

#### STRENGTH-FLUTTER STRUCTURAL OPTIMIZATION OF A SUPERSONIC CRUISE COMBAT AIRCRAFT

B. F. DOTSON (Boeing Military Airplane Co., Seattle, WA) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 208-217. refs

The computer program FASTOP has been developed by an American aerospace company in concert with the U.S. Air Force Flight Dynamics Laboratory. This program resizes a finite element model of a composite structure to a fully stressed design, provides flutter optimization for a specified flutter speed, and then iterates between strength and flutter for an optimized design. The present investigation is concerned with work which was performed to evaluate the use of the program FASTOP in the aircraft design process, taking into account the difficulties which can arise when it is attempted to optimize real life structures. The approach used in the evaluation of FASTOP involved the application of the program to a supersonic cruise combat aircraft. G.R.

### A83-49192

#### THE F-4 FLUTTER SUPPRESSION PROGRAM

G. HAIDL, H. HOENLINGER, and A. LOTZE (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 319-327. refs

New external stores, which have to be carried by a high performance aircraft for tactical reasons, may cause flutter instabilities within the operational flight envelope. The present means of preventing flutter is to limit speed. In other cases, low damping will restrict the performance of the aircraft. Active flutter suppression represents a solution which avoids a reduction in aircraft performance. The present investigation is concerned with studies conducted by a German aerospace company to explore the feasibility of a use of active flutter suppression procedures. Particular attention is given to a program involving the employment of an F-4F aircraft as flying test bed. The program was conducted in cooperation with a West German governmental agency and the U.S. Air Force Flight Dynamics Laboratory. The objective of this effort was to develop and flight test a system for flutter suppression which could become a possible candidate for an operational system. G.R.

### A83-49436

#### A VERY LARGE CARGO AIRCRAFT DESIGN PROJECT

J. P. FIELDING (Cranfield Institute of Technology, Cranfield, England) Aircraft Engineering (ISSN 0002-2667), vol. 55, Sept. 1983, p. 2-11, 14.

A design study for a commercial cargo carrier capable of hauling 165 t of freight and equipped with a kneeling undercarriage is described. The design specifications included a 4000 nm range, a payload of 330-390,000 lb, amenability to 8 x 8 x 20 ft standardized containers, take-off to 35 ft at 11,000 ft of runway, landing in 7,000 ft, and cruise Mach numbers of 0.75-0.8. The design work was completed as part of a project by 19 students, and was initiated by the results of NASA research on the type of airfreight carrier needed in the 1990s. The resultant F-81 aircraft was similar to the C-5A and 10 percent larger. The wings were moderately swept, supercritical, and featured active ailerons to alleviate large bending moments. Account was taken of fuel tankage, an aluminum alloy skin, fuselage loading, and RB211-524D engines. A cabin altitude of 1800 m was included in the environmental control system. M.S.K.

A83-49446

**THE EFFECT OF DAMAGE IN STRUCTURAL ELEMENTS ON THE GROUND RESONANCE OF A HELICOPTER [VLIANIE POVRZHDENII V ELEMENTAKH KONSTRUKTSII NA ZEMNOI REZONANS VERTOLETA]**V. K. LOGINOV *Voprosy Dinamiki i Prochnosti* (ISSN 0321-236X), no. 41, 1983, p. 42-46. In Russian.

A coaxial helicopter model is used to analyze the effect of damage on the dynamic stability in the case of ground resonance. The analysis involves numerical integration of a system of 17 nonlinear second-order differential equations. It is shown that the width of the unstable frequency region can change by as much as 25 percent due to accumulated damage. V.L.

A83-49475#

**CONCEPTUAL DESIGN OF TRANSPORT AIRCRAFT [PROGETTO CONCETTUALE DI VELIVOLI DA TRASPORTO]**S. CHIESA and G. GUERRA (Torino, Politecnico, Turin, Italy) *Ingegneria* (ISSN 0035-6263), July-Aug. 1983, p. 199-209. In Italian.

A minicomputer program for the conceptual design of transport aircraft is characterized. The general aircraft design model is presented and illustrated with a block diagram. Fixed input data, mission requirements, and parameters to be optimized are entered, and specialized subprograms for the estimation of the fuel weight and detailed component weights are applied to produce a tentative design. The optimization subprogram allows the operator to evaluate the tentative design (via a graphic display of the thrust/weight and weight/surface ratios) and choose the parameters to be varied to improve it. Typical graphics and parameter printouts are shown for both jet and propeller aircraft. T.K.

A83-49577#

**DESIGN INTEGRATION OF LAMINAR FLOW CONTROL FOR TRANSPORT AIRCRAFT**R. H. LANGE (Lockheed-Georgia Co., Marietta, GA) *American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983*. 10 p. refs

(AIAA PAPER 83-2440)

This paper discusses Lockheed's progress from 1974 to the present in the practical application of laminar flow control (LFC) to subsonic transport aircraft and includes preliminary design system studies conducted in the Aircraft Energy Efficiency (ACEE) program. Attention is given to the NASA Phase II effort leading to first flight test of the leading-edge cleaning and suction system aboard the NASA Jet Star flight test aircraft in mid-1983. Technology challenges are reviewed in the areas of airfoil development, boundary layer analysis and methods, integrated structural design, the suction system, and the final integrated aircraft configuration. Experimental investigations covered include wind tunnel tests, low-speed flight tests, and tests of structural specimens. The benefits of LFC on drag and fuel efficiency are compared with current transports, as well as with a counterpart turbulent-flow, advanced-technology transport. Author

A83-49579#

**CIVIL TRANSPORT AIRCRAFT DESIGN METHODOLOGY**W. E. ECKELS (Douglas Aircraft Co., Long Beach, CA) *American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983*. 9 p. (AIAA PAPER 83-2463)

A methodology is developed which can be utilized in adopting a configuration for a new aircraft that is responsive to market demands. Configuration variables that affect the overall performance and appeal to the public of the aircraft are examined from the viewpoint of providing the greatest operating efficiency through the use of advanced technology. The selection process for identifying the design features is considered and several specific examples are presented. Several aspects of the configuration design are examined including the airplane range requirements, the technology level, the passenger amenity level, the configuration

sizing, and the configuration optimization. These individual design features are then combined into an aircraft which is sized for an initial configuration. Trade studies conducted in order to arrive at an optimized design are used as concrete examples. N.B.

A83-49584\*# *National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.***AN OVERVIEW OF V/STOL AIRCRAFT DEVELOPMENT**S. B. ANDERSON (NASA, Ames Research Center, Moffett Field, CA) *American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983*. 15 p.

(AIAA PAPER 83-2491)

In reviewing the years of aviation development, it can be seen that vertical-takeoff-and-landing (VTOL) flight was considered before conventional fixed-wing operations. However, it has been difficult to develop a VTOL capability. The present investigation is concerned with a review of the historical development of VTOL aircraft, taking into account lessons learned from a selected group of concepts. Attention is given to the Flying Bedsteads, the tail-sitter designs, the Air Test Vehicle (ATV) and X-14 aircraft, the SC-1, the XV-3 tilt-rotor aircraft, the VZ3-RY deflected slipstream, the X-18 tilt wing, the VZ-2 tilt wing, the VZ-4 ducted fan, the Harrier, the XV-4A (Hummingbird), the Forger, and the XV-15 advanced tilt rotor. G.R.

A83-49587#

**A MCDONNELL DOUGLAS PERSPECTIVE - COMMERCIAL AIRCRAFT FOR THE NEXT GENERATION**R. E. BATES and J. MORRIS (Douglas Aircraft Co., Long Beach, CA) *American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983*. 10 p.

(AIAA PAPER 83-2502)

This paper reviews, from a McDonnell Douglas perspective, the market for the commercial airplane by range and size through 1977. Airframe and propulsion technology is surveyed and improvements in fuel and economic efficiency are predicted. Significant potential gains are shown to be achievable with the application of these technologies. The development costs of new and derivative airplanes are discussed with suggestions made as to which technology developments are suitable for application to derivative aircraft and which are not. The authors then explain why the airline requirements for the 90s will, for the most part, be satisfied by derivatives of existing aircraft, but see the likely development of new aircraft in the 100- to 150-seat short-medium range categories. The final part of the paper describes potential derivatives of the DC-9 and DC-10, and also a new 150-seat short-medium range aircraft. Author

A83-49589#

**DEVELOPMENTS IN UK ROTOR BLADE TECHNOLOGY**R. W. WHITE (Westland Helicopters, Ltd., Yeovil, Somerset, England) *American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983*. 9 p. Research supported by the Ministry of Defence, and Royal Aircraft Establishment.

(AIAA PAPER 83-2525)

During the mid-1970's, a program was initiated in the U.K. with the objective to utilize composites technology in rotor blade design and manufacture. A tail rotor blade was developed first. Advantages of a use of composite materials were found to be related to the economic, reproducible production of sections difficult or impossible to manufacture using metals, and to the greatly improved fatigue life of composite rotor blades. A further advance regarding the utilization of composites is expected for the mid-1980's with the production of a composite main rotor blade for the Lynx/W30 family. The present investigation is concerned with this rotor blade and the aerodynamic and processing developments which the blade embodies. G.R.

**A83-49590\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

## **EXPLORATORY LOW-SPEED WIND-TUNNEL INVESTIGATION OF ADVANCED COMMUTER CONFIGURATIONS INCLUDING AN OVER-THE-WING PROPELLER DESIGN**

J. L. JOHNSON, JR. (NASA, Langley Research Center, Hampton, VA) and E. R. WHITE (Kentron International, Inc., Technical Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 12 p. refs

(AIAA PAPER 83-2531)

A recent low-speed wind-tunnel investigation of a three-surface regional transport configuration has shown large favorable power effects on longitudinal and lateral stability and marginal engine-out trim characteristics for some aft engine and empennage configurations. The present paper discusses these results in terms of static force test information obtained for power-off and power-on conditions. Also discussed in this paper are wind-tunnel results which indicate that mounting propellers over the wing can introduce large favorable slipstream interference effects which significantly reduce the wing drag at climb power conditions. Author

**A83-49592#**

## **ARMY FAMILY OF LIGHT ROTORCRAFT (LHX) CONCEPT FORMULATION**

G. T. SINGLEY, III, R. L. SMITH, and D. P. SCHRAGE (U.S. Army, Aviation Research and Development Command, St. Louis, MO) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 12 p. refs

(AIAA PAPER 83-2552)

The Army Aviation Mission Area Analysis (AAMAA) concluded that major improvements are needed for the Army fleet of the 1990's and beyond. The implementation of these improvements requires a replacement of the Army's existing light fleet of helicopters by a new family of light rotorcraft (LHX). The LHX will be faster and more combat effective than the existing light fleet. Attention is given to the envisaged air-land battle environment, the existing light fleet condition, the advantage of the LHX concept related to a reduction in the number of different types of rotorcraft, aspects of concept formulation, the preliminary design process, measures of effectiveness, the use of simulation during the LHX program, the mission equipment needed to satisfy the Air-Land Battle 2000 Concept, weapons, and questions of supportability. G.R.

**A83-50135#**

## **GENERALIZED FLIGHT OPTIMIZATION EQUATIONS FOR COMMERCIAL AIRCRAFT [SUR LES EQUATIONS GENERALES D'OPTIMISATION DU VOL DES AVIONS DE TRANSPORT]**

A. M. C. RALAITSIZAFY Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 28, July-Aug. 1983, p. 413-425. In French. refs

Flight optimization equations for passenger aircraft are defined, with a focus on minimizing flight costs. Equations of motion are configured to include the pitch moment, the tangential acceleration, and a variable mass for the aircraft, as well as taking into account all possible flight commands available to the pilot. The optimization criteria are controlled by the amount of fuel consumed and the flight duration. Equations are formulated for an optimized trajectory in terms of extremum values, with the constraints expressed by the state variables. A system of differential equations is obtained which is solved by a gradient method. M.S.K.

**A83-50140#**

## **PARAMETRIC TIP EFFECTS FOR CONFORMABLE ROTOR APPLICATIONS**

W. R. MANTAY and W. T. YEAGER, JR. (U.S. Army, Army Structures Laboratory, Hampton, VA) Associazione Industrie Aerospaziali and Associazione Italiana di Aeronautica ed Astronautica, European Rotorcraft Forum, 9th, Stresa, Italy, Sept. 13-15, 1983, Paper. 30 p. refs

The impact of selected blade tip geometric parameters on aeroelastically conformable rotor (ACR) performance and loads characteristics was examined experimentally. The ACR feature passive control in the form of a hingeless rotor blade that can deform passively in response to aerodynamic stresses. Wind tunnel trials were performed with Freon-12 as the medium and a 0.175 scale four-bladed model with soft torsional rotors. The blades were configured with adjustments possible at the 89 percent radius, and monitoring was performed of the rotor forces and moments, the blade loads, and the pitch link loads. Flapping, lagging, pitch, and rpm were also recorded. Seven blade tip designs were examined, and the results indicated that a torsionally soft ACR tip shapes degraded the performance of the blades. Rotors with the lowest oscillatory flapwise loads displayed the best performance. A strong correlation was established between azimuthal variation of the elastic twist and rotor performance and loads, with small azimuthal elastic twist yielding the higher performance. M.S.K.

**A83-50141#**

## **AEROMECHANICAL STABILITY OF A HINGELESS ROTOR IN HOVER AND FORWARD FLIGHT - ANALYSIS AND WIND TUNNEL TESTS**

W. T. YEAGER, JR., W. R. MANTAY (U.S. Army, Army Structures Laboratory, Hampton, VA), and M.-N. H. HAMOUDA (Vigyan Research Associates, Inc., Hampton, VA) Associazione Industrie Aerospaziali and Associazione Italiana di Aeronautica ed Astronautica, European Rotorcraft Forum, 9th, Stresa, Italy, Sept. 13-15, 1983, Paper. 20 p. refs

The ground resonance of soft inplane hingeless rotors was modeled analytically and the results were compared with experimental data. The numerical model applied was the Comprehensive Analytical Model of Rotorcraft Aerodynamics and Dynamics (CAMRAD), which used as input the elastic degrees of freedom in flap bending, lead-lag bending and torsion, and a rigid pitch degree of freedom. The output described the elastic motion of the fuselage and rotor support system in the wind tunnel. Both flutter and trim analyses were performed. A soft inplane hingeless rotor with NACA 0012 blades was subjected to trials in the NASA Langley Transonic Dynamics Tunnel with Freon-12 as the test medium. The tests covered conditions of hover and forward flight. Data were gathered on the rotor lead-lag regressing mode damping. The model correctly predicted the ground resonance instability experienced in the hover trials, and the frequency and damping values of the lead-lag regressing mode in hover and forward flight. M.S.K.

**N83-34901#** British Aerospace Public Ltd. Co., Preston (England). Aircraft Group.

## **INTEGRATION OF A NEW SENSOR ON TO AN EXISTING AIRCRAFT**

A. S. LEYLAND In AGARD Advan. in Sensors and their Integration into Aircraft Guidance and Control Systems 7 p Jun. 1983 Avail: NTIS HC A08/MF A01

Although all sensors have differencing requirements the principles described apply to every integration task. To demonstrate the technique, an assumption was made that a requirement exists to assist the crew in poor visibility by fitting a low light sensor. The requirement and the aircraft system to which it is fitted are fictitious, although representative of current systems. The method used is Top Down Design, which takes the original requirement, breaks it down to various functions and processes and then recreates it into various line replaceable units, and software requirements, in a structured compatible format. Author

**N83-34934\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**DUAL TOWLINE ANTI-SPIN DEVICE Patent Application**

W. L. WHITE, inventor (to NASA) 15 Sep. 1983 15 p  
(NASA-CASE-LAR-13076-1; US-PATENT-APPL-SN-532342)  
Avail: NTIS HC A02/MF A01 CSCL 01C

A device which corrects aerodynamic spin with a parachute that exerts anti-spin forces on an aircraft to effect spin recovery is described. The dual parachute towlines are each attached to the parachute and are attached to the rear fuselage equidistant to and on opposite sides of the aircraft centerline. As the parachute is deployed during spin, the parachute force acts through only the towline, and exerts its force outboard of center on the aircraft. As a result, the parachute exerts not only an anti-spin torque, but additionally causes the aircraft to roll, creating a gyroscopic anti-spin rolling moment. The additional and anti-spin rolling moment facilitates spin recovery by permitting a relatively smaller parachute to accomplish spin recovery equivalent to that of a larger parachute attached to the center of the rear fuselage.

NASA

**N83-34935\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**BRAKING AND CORNERING STUDIES ON AN AIR CUSHION LANDING SYSTEM**

R. H. DAUGHERTY Sep. 1983 25 p refs  
(NASA-TP-2196; L-15640; NAS 1.60:2196) Avail: NTIS HC A02/MF A01 CSCL 01C

An experimental investigation was conducted to evaluate several concepts for braking and steering a vehicle equipped with an air cushion landing system (ACLS). The investigation made use of a modified airboat equipped with an ACLS. Braking concepts were characterized by the average deceleration of the vehicle. Reduced lobe flow and cavity venting braking concepts were evaluated in this program. The cavity venting braking concept demonstrated the best performance, producing decelerations on the test vehicle on the same order as moderate braking with conventional wheel brakes. Steering concepts were evaluated by recording the path taken while attempting to follow a prescribed maneuver. The steering concepts evaluated included using rudders only, using differential lobe flow, and using rudders combined with a lightly loaded, nonsteering center wheel. The latter concept proved to be the most accurate means of steering the vehicle on the ACLS, producing translational deviations two to three times higher than those from conventional nose-gear steering. However, this concept was still felt to provide reasonably precise steering control for the ACLS-equipped vehicle.

Author

**N83-34936#** Naval Postgraduate School, Monterey, Calif.  
**GRAPHIC ENHANCEMENT OF THE AIRCRAFT PENETRATION MODEL FOR USE AS AN ANALYTIC TOOL M.S. Thesis**

D. F. MOTZ Mar. 1983 219 p refs  
(AD-A128226) Avail: NTIS HC A10/MF A01 CSCL 09B

The Aircraft Penetration Model (ACPEN) is an event store computer simulation of the interaction between surface-to-air missile sites and airframes attempting to penetrate the defended area. Statistical and event data produced by the model in list and tabular form requires item by item comparison for use in planning and analysis. By using a computer graphics software package to present the data produced by the ACPEN simulation, use of the model as a planning and analytic tool is enhanced. Of particular use is a map graphic product which shows spatial relationships and events. The simulation area displayed and composition of the map can be interactively varied by a planner to meet specific planning needs.

Author (GRA)

**N83-34937#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**MIKOYAN MIG-23, USSR**

12 Apr. 1983 8 p refs Transl. into ENGLISH from Techn. Lotnicza Astronautyczna (Poland), v. 38, no. 6, 1982 p 17-18  
(AD-A128293; FTD-ID(RS)T-0291-83) Avail: NTIS HC A02/MF A01 CSCL 01C

Fuselage, control surfaces, undercarriage, propulsion, equipment and armament for the Mikoyan MiG 23 aircraft are summarized.

Author

**N83-34938#** Tactical Air Command, Langley AFB, Va.

**THE APC-4 INFRARED PLUME GENERATOR QUALIFICATION OPERATIONAL TEST AND EVALUATION (QOT/E)**

3 May 1983 8 p refs  
(AD-A128503) Avail: NTIS HC A02/MF A01 CSCL 17E

A qualification operational test and evaluation of the operational effectiveness and operational suitability IAW AFM 55-43 of the APC-4 infrared plume generator installed first in J-69, and subsequently J-85, engine configured BQM-34A targets and flown in an actual WSEP environment were performed. The capability to provide IR augmentation to simulate the aircraft signatures and to meet the IR augmentation requirements of the WSEP users was assessed.

S.L.

**N83-34939#** Southampton Univ. (England). Dept. of Aeronautics and Astronautics.

**TECHNICAL EVALUATION REPORT ON THE FLIGHT MECHANICS PANEL SYMPOSIUM ON GROUND/FLIGHT TEST TECHNIQUES AND CORRELATION**

J. WILLIAMS Jun. 1983 30 p refs  
(AGARD-AR-191; ISBN-92-835-1454-8) Avail: NTIS HC A03/MF A01

Twenty-four papers and the panel discussions are reviewed. Topics covered include: (1) aerodynamic performance prediction and correlation; (2) status of aerodynamic performance prediction; (3) flying qualities considerations; (4) aeroelastic effects; and (5) subsystem performance.

A.R.H.

**N83-36022\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**COMPARISON OF ADVANCED TURBOPROP AND TURBOFAN AIRPLANES**

V. S. JOHNSON Sep. 1983 30 p refs Presented at the AIAA Appl. Aerodyn. Conf., Danvers, Mass., 13-15 Jul. 1983  
(NASA-TM-85692; NAS 1.15:85692; AIAA-PAPER-83-1823)  
Avail: NTIS HC A03/MF A01 CSCL 01C

Results of a parametric study to determine the effects of design variables and penalties on the fuel efficiency of Mach 0.8, 125-passenger, advanced turboprop airplanes show that propeller-wing interference penalty has a major effect. Propeller tip speed has a minor effect, and could be decreased to alleviate the noise problem without significant effects on fuel efficiency. The anticipated noise levels produced by the propfan will require additional acoustical treatment for the fuselage; this additional weight can have a significant effect on fuel efficiency. The propfan advantage over an equivalent technology turbofan is strongly dependent on the interference penalty and acoustical treatment weight. Lowering the cruise Mach number to around 0.73 would result in greatly increased fuel efficiency.

Author

**N83-36023#** Aeronautical Research Labs., Melbourne (Australia).

**SEA KING HELICOPTER FLIGHT TRIALS**

C. R. GUY and M. J. WILLIAMS Jan. 1983 61 p refs  
(ARL-AERO-NOTE-415; AR-002-938) Avail: NTIS HC A04/MF A01

A program of flight trials carried out with a Sea King Mk. 50 helicopter is described. An outline is given of the aircraft instrumentation, the data acquisition system and the data analysis procedures. Results are presented for conditions of trimmed level flight together with typical examples of dynamic response tests, transition maneuvers and Doppler and cable hover tests. A

## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

summary of the flight test schedule and objectives is included to indicate the scope of the flight trials program. This program was designed to provide results for use in the validation of the Sea King Mk. 50 mathematical model and for more general use in helicopter behavior studies. Author

**N83-36024#** Naval Postgraduate School, Monterey, Calif. Dept. of Aeronautics.

### **GUIDE FOR CONCEPTUAL HELICOPTER DESIGN M.S. Thesis**

S. G. KEE Jun. 1983 123 p refs

(AD-A128974) Avail: NTIS HC A06/MF A01 CSCL 051

A conceptual helicopter design method utilizing closed form formulas and approximations from historical data is developed for use in a helicopter design course. The design manual is to be used for the conceptual design of a single main rotor, utility helicopter. The manual was written principally for use in AE4306-Helicopter Design. Author (GRA)

**N83-36025#** Army Aviation Engineering Flight Activity, Edwards AFB, Calif. Directorate for Development and Qualification.

### **AIRWORTHINESS AND FLIGHT CHARACTERISTICS (AFC) TEST OF YAH-64 ADVANCED ATTACK HELICOPTER, PROTOTYPE QUALIFICATION TEST-GOVERNMENT (PQT-G), PART 3 AND PRODUCTION VALIDATION TEST-GOVERNMENT (PVT-G) FOR HANDBOOK VERIFICATION Final Report, 12 May - 19 Aug. 1982**

B. D. PICASSO, III, G. T. DOWNS, R. M. BUCKANIN, and M. K. HERBST Oct. 1982 272 p refs  
(AD-A130524; USAAEFA-80-17-3) Avail: NTIS HC A12/MF A01 CSCL 01C

The Airworthiness and Flight Characteristics Test of the YAH-64 helicopter was conducted. Seventy flights and 70.4 productive hours were flown. Performance testing assessed the probability of meeting the production contract requirements and consisted of an evaluation of hover, takeoff, level flight, forward flight climb and autorotational descent performance. Handling qualities testing determined compliance with selected research and development contract requirements and included standard stability and control tests, an evaluation of slope landing characteristics and instrument flight capability. Additional tests included evaluation of an uprated engine and an external noise survey. The YAH-64 now meets the performance requirements of the system specification for the production program; the vertical climb and maximum level flight cruise speeds. Slope landing characteristics were satisfactory up to 9 degree lateral slopes and 10 degree longitudinal slopes. GRA

**N83-36026#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

### **CHINA'S QIANG 5 ATTACK AIRCRAFT**

A. BA 15 Jun. 1983 12 p Transl. into ENGLISH from Comilit (China), v. 6, no. 11, issue 74, 1 Jan. 1983 p 36-39  
(AD-A130117; FTD-ID(RS)T-0458-83) Avail: NTIS HC A02/MF A01 CSCL 01C

Mainland Chinese military aircraft production is reviewed. The Qiang 5 attack aircraft and the Jian 6 fighter aircraft are discussed. Technical assistance from other countries is also discussed. N.W.

**N83-36027#** Sikorsky Aircraft, Stratford, Conn.

### **MODEL HH-53 HELICOPTER, DURABILITY AND DAMAGE TOLERANCE ASSESSMENT REPORT SUBMITTAL Monthly Status Letter**

13 May 1983 6 p

(Contract F09603-81-G-1808)

(AD-A129255; SEL-7867) Avail: NTIS HC A02/MF A01 CSCL 01C

Progress continued this month on the NASTRAN model of the forward cabin. Some program slippage was experienced in both the mass distribution and updating cabin stiffness. The transmission and sponson geometry definition was reassigned to the CAD group and new commitments from the weights group were obtained. The program should be back on schedule by April 15. Screening

of sensitive dynamic components has also been started. Overall expenditures are about 18% of budget at this point. Although light, the charges are expected to rise as the NASTRAN model of the aft fuselage is generated. This will have to be a complete new model unlike the forward cabin which is a modified CH-53E model. Author (GRA)

## 06

## AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

**A83-47186#**

### **MODERN DIGITAL AIR-DATA COMPUTER [MODERNER DIGITALER LUFTWERTERECHNER]**

D. WALDMAN (Nord-Micro Elektronik Feinmechanik AG, Frankfurt am Main, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 16 p. In German.

A modern digital air-data computer was developed by a company in West Germany. The computer is based on the utilization of a 16-bit microprocessor. The introduction of the new computer provides a number of improvements with respect to previous air data systems. The improvements are related to an enhancement of system reliability, the development of standard structural components, and a reduction of cost, weight, and volume. It is planned to use the air-data computer for the Airbus A310. The device is employed on the airliners of the Lufthansa since 1983. Attention is given to the air-data system of the Airbus A310, the various air-data processing systems, the characteristics of modern air-data computers, the pressure transducer, the software structure, the self-test characteristics of the system, and trends regarding the development of future air-data systems. G.R.

**A83-47187#**

### **STATE OF THE ART AND DEVELOPMENT POTENTIAL OF FIBEROPTIC ROTATION SENSORS [ENTWICKLUNGSSTAND UND -POTENTIAL DES FASEROPTISCHEN ROTATIONSENSORS]**

W. AUCH (Standard Elektrik Lorenz AG, Stuttgart, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 16 p. In German. refs

**A83-48346\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

### **EVALUATION OF CONTROL AND DISPLAY CONFIGURATIONS FOR HELICOPTER SHIPBOARD OPERATIONS**

C. H. PAULK, JR. (NASA, Ames Research Center, Moffett Field, CA), S. T. DONLEY (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA), and M. K. HOLLIS (U.S. Navy, Naval Air Test Center, Patuxent River, MD) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 14 p. refs

(AIAA PAPER 83-2486)

A simulation evaluation of several approach and landing flight-control configurations and of two out-of-the-cockpit display devices (a head-up display and a helmet-mounted display) was performed for the task of landing a helicopter on a destroyer in adverse weather. The results indicated that the ship airwake turbulence was the most significant environmental variable affecting hover performance. In addition, to achieve adequate landing performance, attitude-command control compensation was required for the pilot regardless of the display used. For improved performance with reduced pilot effort, a velocity-command, position-hold control system was desired. Author



A83-48348#

**OPERATIONAL AND CONTROL DISPLAY CONCEPTS FOR FLIGHT MANAGEMENT SYSTEMS IN NEW GENERATION TRANSPORT AIRCRAFT**

M. B. ADAMS (Sperry Corp., Phoenix, AZ) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 7 p. (AIAA PAPER 83-2489)

The emerging world oil shortage led to area navigation systems (RNAV) and fuel economy studies in the early 1970s. It was found that a number of potential benefits would result from accurate control of the aircraft's longitudinal as well as lateral axes. By the late 1970s, at the time of the evolution of the conceptual design for a new airliner in the U.S. and another airliner in Europe, a digital avionics architecture was developed. Both airliners make maximum use of digital technology, including flight management, automatic flight-control systems, and electronic flight instruments (EFIs). The flight management computer system (FMCS) represents the heart of the avionics system. It handles the basic functions of performance management, navigation, guidance, and the related display functions. Attention is given to a functional overview, a control display overview, and advanced control/display concepts.

G.R.

A83-48518

**COMPARATIVE ANALYSIS OF THE EFFICIENCY OF PRACTICAL REALIZATIONS OF THE KALMAN ALGORITHM [SRAYNITEL'NYI ANALIZ EFEKTVNOSTI PRAKTICHESKIKH REALIZATSII ALGORITMA KALMANA]**

IU. N. VOLOVIK, V. I. DNEPROVSKII, and V. G. KOROLEVA Radiotekhnika (ISSN 0033-8486), Aug. 1983, p. 44-47. In Russian. refs

A group (eight variants) of discrete filtering (Kalman) algorithms is examined with reference to application in a microwave landing system. The variants are evaluated by means of Monte Carlo simulation with subsequent comparison of the accuracy characteristics obtained with the optimal characteristics. Computing-facility costs are evaluated for the case of practical realization on a microcomputer.

B.J.

A83-48640

**GENERAL AVIATION GOES DIGITAL - MANY ADVANTAGES, BUT SOME PROBLEMS**

P. CONDOM Interavia (ISSN 0020-5168), vol. 38, Sept. 1983, p. 929-931.

Digital technology being introduced into general aviation is discussed in terms of its advantages and problems. The choice of stand-alone systems or standards is addressed, and the potential of the bidirectional multiplex digital bus as a technological solution is considered. Digital applications in electronic flight instruments are covered, and the integration of multiple systems by digital methods is discussed.

C.D.

N83-34892# Marconi Avionics Ltd., Basildon (England).

**THE STATUS OF LLTV FOR AVIONIC APPLICATIONS**

W. J. R. CLARK /In AGARD Advan. in Sensors and their Integration into Aircraft Guidance and Control Systems 10 p Jun. 1983

Avail: NTIS HC A08/MF A01

An historical review of the development of low light television (LLTV) cameras is presented the operating principles and salient characteristics of the two types of camera tube suitable for avionic applications are described. The natural environment in which such systems must operate and the fundamental and practical limitations to their performance are also described. The alternatives and applications experience based upon practical flight trials were compared.

Author

N83-34895#

Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen (West Germany).

**INTRODUCTION TO OPTICAL RATE SENSORS**

U. K. KROGMANN /In AGARD Advan. in Sensors and their Integration into Aircraft Guidance and Control Systems 35 p Jun. 1983 refs

Avail: NTIS HC A08/MF A01

After dealing with the reasons of optical rate sensor penetration in the near future a short introduction to the physical function and basic design of passive and active optical rate sensors was given. Particularly the passive sensors are expected to yield a decisive breakthrough in the future since they seem to offer a more favorable cost versus performance potential as compared to the active ring laser gyro. The realization of the relatively simple physical principles of optical rate measurements as treated here involves new gyro technology problems which now refer to the electro-optics, laser physics and integrated optics rather than to the precision mechanics. Feasibility problems today regarding passive sensors should be alleviated in the future where the inertial field can benefit from developments within the optical communication field. As far as the active ring laser gyro is concerned it has obtained a high level of maturity being ready for mass production. However, it is still an expensive sensor.

Author

N83-34897\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**LOW COST FLUIDIC SENSORS**

H. D. GARNER /In AGARD Advan. in Sensors and their Integration into Aircraft Guidance and Control Systems 10 p Jun. 1983 refs

Avail: NTIS HC A08/MF A01 CSCL 01D

The gyroscopic inertial sensors used in general aviation autopilots and in stability augmentation systems probably contribute more than any other component to the initial cost and to the continuing maintenance costs of these installations. Several fluidic devices which were developed to replace the gyroscopes in the conventional "wing-leveler" type autopilots used in small, general aviation airplanes are described. These sensors are characterized by simplicity of design, ease of fabrication, and lack of wearing parts. A unique, fluidic, true airspeed sensor is also described. All these devices are adapted to fabrication by low cost plastic molding techniques, and their lack of wearing parts promises long, maintenance free service lives.

Author

N83-34898# Royal Aircraft Establishment, Bedford (England).

**AIRSPEED AND WIND SHEAR MEASUREMENTS WITH AN AIRBORNE CO<sub>2</sub> CW LASER**

A. A. WOODFIELD and J. M. VAUGHAN (Royal Signals and Radar Establishment) /In AGARD Advan. in Sensors and their Integration into Aircraft Guidance and Control Systems 18 p Jun. 1983 refs

Avail: NTIS HC A08/MF A01

The Laser True Airspeed System (LATAS) installed on the RAE HS125 research aircraft is described. It has proved exceptionally reliable and rugged. Examples of results are presented including a climb to 43000 ft; flight through a severe thunderstorm wind shear (microburst); pressure error measurements; and signals observed in cloud, heavy rain and from solid objects such as the ground. Some thoughts on other potential applications such as using the sensor for an intelligent autothrottle, for measuring crossflow velocities; for measuring tire and ground speeds to save tire wear; and as a combined air data and ground velocity system for helicopters (including a facility to maintain a steady hover) are presented.

Author

**N83-34899#** Royal Aircraft Establishment, Farnborough (England).

**AUTOMATIC SPEECH RECOGNITION AS A COCKPIT INTERFACE**

R. G. WHITE /In AGARD Advan. in Sensors and their Integration into Aircraft Guidance and Control Systems 16 p Jun. 1983 refs

Avail: NTIS HC A08/MF A01

The future use of automatic speech recognition machines for the management of cockpit systems and for low bandwidth air-ground communications is discussed. After describing the principles of speech recognition, the benefits afforded to the aircrew are considered. These are balanced against the difficulties of operating in the cockpit environment. The effects that this maturing technology is likely to have on cockpit design and operating procedures are discussed. Techniques for training machines to recognize the aircrew's utterances are considered. The future for the avionic applications of automatic speech recognition is promising. A great deal of relevant research is being undertaken within NATO countries, including flight research programs planned for 1982. Author

**N83-34940#** Naval Training Equipment Center, Orlando, Fla. **HELMET MOUNTED FEASIBILITY MODEL Final Report, Sep. 1981 - Feb. 1983**

J. H. ALLEN and R. C. HEBB Feb. 1983 78 p refs (AD-A128150; NAVTRAEQUIPC-IH-338) Avail: NTIS HC A05/MF A01 CSCL 05E

A feasibility model of an advanced visual display system for flight simulation is described. The feasibility model is comprised of a video projector mounted on a pilot's helmet which projects a computer generated image onto a spherical screen. The video projector utilizes a laser light source in forming the projected video raster. The display is slaved to the viewer's head pointing direction via a magnetic head tracking device, and results in imagery that is generated and displayed for the instantaneous viewing direction of the observer. Since the computer image generator requires a measurable period of time to create an image for a specific head pointing direction, an undesirable display orientation error is induced each time the viewer moves his head. A method of continuously compensating for this image display error was provided and is described. This feasibility model has demonstrated successfully, on a small scale, the helmet mounted display concept. This concept will be utilized in a full scale development model scheduled for delivery under contract in 1985. Author (GRA)

**N83-36028\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**EFFECT OF LEAD-AIRCRAFT GROUND-SPEED ON SELF-SPACING PERFORMANCE USING A COCKPIT DISPLAY OF TRAFFIC INFORMATION**

J. R. KELLY Oct. 1983 50 p refs (NASA-TP-2194; L-15402; NAS 1.60:2194) Avail: NTIS HC A03/MF A01 CSCL 01D

A simulator investigation was conducted to determine the effect of the lead-aircraft ground-speed quantization level on self-spacing performance using a Cockpit Display of Traffic Information (CDTI). The study utilized a simulator employing cathode-ray tubes for the primary flight and navigation displays and highly augmented flight control modes. The pilot's task was to follow, and self-space on, a lead aircraft which was performing an idle-thrust profile descent to an instrument landing system (ILS) approach and landing. The spacing requirement was specified in terms of both a minimum distance and a time interval. The results indicate that the ground-speed quantization level, lead-aircraft scenario, and pilot technique had a significant effect on self-spacing performance. However, the ground-speed quantization level only had a significant effect on the performance when the lead aircraft flew a fast final approach. Author

## AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

**A83-47183#**  
**DEVELOPMENT OF NEW COMBUSTION CHAMBER TECHNOLOGIES FOR FUTURE ALTERNATIVE COMBUSTION FUELS [ENTWICKLUNG NEUER BRENNKAMMER-TECHNOLOGIEN FUER ZUKUNFTIGE ALTERNATIVE BRENNSTOFFE]**

B. SIMON (Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 34 p. In German. refs

New technological developments which will permit the reduction of flame tube wall temperatures, of smoke emissions, and of combustion chamber size are discussed. New combustion material specifications resulting from the studies are briefly addressed, and aircraft gas turbine results are presented. Fuel injection systems, cooling film configurations, layering with heat-resistant materials, and developments in air atomization nozzles are discussed. C.D.

**A83-47194#**  
**AN IMPROVED PROPELLER FOR GENERAL-AVIATION AIRCRAFT [EIN VERBESSERTER PROPELLER FUER FLUGZEUGE DER ALLGEMEINEN LUFTFAHRT]**

H. ZIMMER (Dornier GmbH, Friedrichshafen, West Germany) and R. HOFFMANN (Hoffmann Propeller, Rosenheim, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 81 p. In German. Sponsorship: Bundesministerium fuer Forschung und Technologie. refs (Contract BMFT-LFK-7831)

The development and testing of an aerodynamically advanced propeller for 5-14-ton aircraft are reported. Flight and wind-tunnel tests were performed on commercial propellers, and aerodynamic and acoustic calculations revealed possibilities for improvement, especially in low and medium speed ranges. A fiber-glass-coated epoxy-laminated wood construction was chosen for its light weight (about 20 kg lighter than a metal propeller of similar size) and improved harmonic-damping and fatigue performance. Ground and flight tests of one of the optimized propellers show a 19-percent improvement in standing thrust, a 10-16-percent greater climbing speed (in a one-motor configuration), and a 5-dBA lower standing noise level (at equal thrust) compared to the best conventional propeller. A 3-blade version is currently being certified for use on the Do-228 two-engine aircraft. T.K.

**A83-47202#**  
**INCREASED ENERGY EXPLOITATION IN COOLED HIGH-TEMPERATURE TURBINES [STEIGERUNG DER ENERGIEAUSNUTZUNG IN GEKUEHLTEN HOCHTEMPERATUR-TURBINEN]**

H.-J. DIETRICH (Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 42 p. In German. refs

Theoretical and experimental work to apply aircraft engine technology to improve energy exploitation in cooled high-temperature turbines is discussed. Comprehensive experimental and analytical cooling research using laser measurement techniques is reported and the design of a high-load transonic turbine is presented. Theoretical studies aimed at increasing design accuracy and lowering development costs are

addressed. A procedure which uses cooling films to optimize blade profiles is presented along with the numerical bases for a computer program for three-dimensional calculation of frictionless flow. A procedure to determine the origin and propagation of turbine noise is presented which offers the possibility of actively reducing noise emission from aircraft engines. C.D.

#### A83-47217#

#### A NEW-TECHNOLOGY GAS GENERATOR FOR MEDIUM-POWER SHAFT-TURBINE ENGINES (GASGENERATOR NEUER TECHNOLOGIE FUER WELLENTRIEBWERKE MITTLERER LEISTUNG)

K. TRAPPMANN, H. MERZ, and U. SCHMIDT-EISENLOHR (Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 29 p. In German. refs

The current development status of the gas generator (comprising compressor, combustion chamber, compressor turbine, intake and output housings, gearing for attached devices, and attachments required for operation) for a 900-kW aircraft propulsion engine is reported. The design is an improved version of the VT-1B generator, using only three stages in the axial compressor and one stage in the compressor turbine. The design and construction of the advanced turbine components are described and illustrated with photographs and drawings, with discussion of compressor aerodynamics, adaptation of the combustion chamber to alternative fuels, air-cooling system, clearance control, and the use of composite materials. The construction of the prototype is about 60 percent complete, and initial running tests are planned for 1984. T.K.

#### A83-47879#

#### THE USE OF PRODUCTION HARDWARE FOR THE DEVELOPMENT OF CONTROL LAWS

I. LEARMAN and N. J. B. YOUNG (Dowty Electronics, Ltd., Watford, Herts., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. (ASME PAPER 83-GT-6)

The introduction of large-scale integration techniques into electronics has been accompanied by the wider use of digital computational techniques to replace functions previously performed in analog electronic technology. Engine control technology has benefited by this development in connection with the design of smaller and more powerful electronic control systems. Difficulties, however, are associated with the generation of software appropriate for the controllers. The two phases of development of an engine controller include a breadboard/development unit phase, and a phase concerned with studies involving a preproduction standard unit. The present investigation addresses the second phase. The essential differences between the dedicated control system and the general purpose system are discussed, and an approach is shown for overcoming these differences in order to provide a flexible development system on the basis of the dedicated controller. G.R.

#### A83-47881#

#### ON THE INFLUENCE OF THE DIFFUSER INLET SHAPE ON THE PERFORMANCE OF A CENTRIFUGAL COMPRESSOR STAGE

M. JANSEN, M. RAUTENBERG (Hannover, Universitaet, Hanover, West Germany), and K. BAMMERT American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. refs (ASME PAPER 83-GT-9)

Results from an experimental study of the influence of the diffuser inlet shape on the performance of the diffuser and the whole compressor stage are presented. The investigations were carried out using a single stage centrifugal compressor. Three different vaned diffusers were tested. From detailed flow field measurements the influence of the diffuser inlet shape on the

performance of the essential components of the compressor stage, i.e. the impeller, the diffuser, and the collecting chamber was analyzed. It is shown that the reaction of the vaned diffuser on the efficiency of the impeller is only weak but the losses in the collecting chamber are considerably affected by the used diffuser types. Author

#### A83-47893#

#### COMBUSTION EXPERIMENTS WITH A NEW BURNER AIR DISTRIBUTION CONCEPT

S. J. MARKOWSKI, R. L. MARSHALL (United Technologies Corp., Platt and Whitney Group, East Hartford, CT), and B. V. JOHNSON (United Technologies Research Center, East Hartford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. Research supported by the United Technologies Corp. (ASME PAPER 83-GT-31)

Experiments were conducted with a JT8D-engine sized can combustor which had all the combustion and dilution air entering through the burner front face. The primary and secondary/dilution air inlet geometries the primary fuel injection configuration, the air inlet conditions and the fuel flow rates for the combustor were varied in a series of parametric low power combustion experiments. Measurements included exit plane emissions, total pressure and total temperature distributions and burner liner temperature distributions. Attractive emission levels, temperature pattern factors and wall temperatures were achieved with low burner pressure losses for the good combinations of geometry and flow conditions. Author

#### A83-47898#

#### A CONFIGURATION TO IMPROVE THE AERODYNAMICS AND SCOPE OF CAN-ANNULAR COMBUSTORS

R. C. ADKINS and D. BINKS (Cranfield Institute of Technology, Cranfield, Beds., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. Research sponsored by the Rolls-Royce, Ltd. (ASME PAPER 83-GT-37)

Aerodynamic tests on a novel concept of precombustor diffuser, particularly suited to can-annular configurations, are described. These tests show that the new arrangement avoids the unstable flow separations and some of the parasitic pressure losses which can be experienced in more conventional arrangements. With the benefit of improved flow conditions, it is argued that the can-annular combustor arrangement has many advantages over other configurations, particularly for large engines, and where exhaust gas pollutants must be kept to a minimum. Author

#### A83-47902#

#### A SIMPLE METHOD FOR DESIGNING OPTIMUM ANNULAR DIFFUSERS

R. C. ADKINS (Cranfield Institute of Technology, Cranfield, Beds., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs (ASME PAPER 83-GT-42)

A simple method is developed for designing optimum annular diffusers which enables the attainment of maximum static pressure recovery within a specified length. The design route is based on the accurate translation of data taken from the family of conical Cp(asterisk) diffusers, which produce the maximum pressure recovery within a stipulated length, to those of annular configuration by employing an appropriate correlating parameter. Data are presented which support the credibility of the design, although it is noted that the technique may not be completely reliable in cases where there is excessive distortion present in the flow at inlet, where there is a sharp discontinuity in the wall profile, and when there is a considerable degree of wall curvature. The adaptation of this method to account for compressible (but subsonic) flow is presented. N.B.

## 07 AIRCRAFT PROPULSION AND POWER

**A83-47903#**

### **A COMPACT DIFFUSER SYSTEM FOR ANNULAR COMBUSTORS**

R. C. ADKINS (Cranfield Institute of Technology, Cranfield, Beds., England) and J. O. YOST (Rolls-Royce, Ltd., Bristol, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. refs

(ASME PAPER 83-GT-43)

Airflow tests have been conducted on an aerodynamic simulation of a combustor with prediffuser of compact configuration. The inlet Mach number throughout the test was 0.35. The configuration was successful because of the attainment of a high pressure recovery coupled with an exceptionally low total pressure loss. A useful analytical relationship is derived between the aerodynamic performance of combustor, compressor exit Mach number and diffuser performance. Author

**A83-47908#**

### **THE ROLLS-ROYCE ANNULAR VAPORIZER COMBUSTOR**

A. SOTHERAN (Rolls-Royce, Ltd., Bristol, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. refs

(ASME PAPER 83-GT-49)

The 'vaporizer' fuel injector, which directs fuel upstream toward the combustor head in gas turbine engines, is currently employed in the engines of the Concorde SST, Tornado fighter and AV-8 VTOL aircraft. With the experience gained in these applications, the operating characteristics of combustors of this type are firmly established and it becomes possible to design similar combustors for novel engines with a high degree of confidence and a minimum of development. On this basis, the vaporizer has been specified for the combustor of the RB211-CE3 advanced technology engine. Attention is given to the development history of this family of combustor designs, which have been incorporated in the Sapphire, Viper, Pegasus, and Olympus 593 engines. O.C.

**A83-47911#**

### **MIXING AND FUEL ATOMISATION EFFECTS ON PREMIXED COMBUSTION PERFORMANCE**

G. E. ANDREWS, M. M. ABDUL AZIZ, and N. A. AL-DABBAGH (Leeds University, Leeds, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. Research supported by the Science and Engineering Research Council of England and Ruston Gas Turbines. refs

(ASME PAPER 83-GT-55)

The main objective was to compare a flame stabilizer at constant pressure loss and identical isothermal aerodynamics with three modes of fuel injection: premixed, direct propane injection and direct kerosene injection. A Jet Mixing type of flame stabilizer was used at simulated gas turbine primary conditions. The influence of gaseous mixing effects was to deteriorate the combustion efficiency solely by increasing the CO emissions and to increase the NO(x) emissions. The flame stability was increased and low CO emissions were achieved at weaker mixtures. Liquid fuel atomization effects resulted in a further deterioration in combustion efficiency due solely to unburnt hydrocarbons. However, the NO(x) emissions were reduced indicating that local stoichiometric burning around single droplets does not occur. Author

**A83-47912#**

### **A SMALL ENGINE HIGH TEMPERATURE CORE RESEARCH PROGRAMME**

A. W. BURGESS (Rolls-Royce, Ltd., Leavesden, Herts., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. Research supported by the Ministry of Defence (Procurement Executive). (ASME PAPER 83-GT-56)

A general description of a small engine high temperature research vehicle is presented along with other aspects of the

associated programme directed primarily towards the investigation of an air cooled turbine system. The general philosophy and style of the programme is discussed and comparisons made with alternative approaches. The instrumentation used is detailed along with a brief review of the test facility and data retrieval system. The presentation of engine design features and results is limited due to the classified nature of the work. The project is reviewed in the light of the 5 years test experience gained. Author

**A83-47915#**

### **THE PURPOSE, THE PRINCIPLES AND THE PROBLEMS OF FAULT TOLERANT SYSTEMS**

E. S. ECCLES (Dowty and Smiths Industries Controls, Ltd., Cheltenham, Glos., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. refs

(ASME PAPER 83-GT-59)

The range of fault tolerance system configuration choices open to the control system designer is surveyed and their main characteristics and spheres of application are classified. Eleven systems are considered, some in detail. The influence of application, installation, powerplant/vehicle configuration, and complexity of control hardware on the choice of system is addressed. The choice of actuation system, monitoring methods, failure recovery, and software is discussed. Relative representative cost and reliability figures are given for each configuration and for relative sizes and weights where aviation considerations are paramount. C.D.

**A83-47919#**

### **INVESTIGATION OF F/A-18A ENGINE THROTTLE USAGE AND PARAMETRIC SENSITIVITIES**

C. L. HALL, R. W. HATHAWAY (McDonnell Aircraft Co., St. Louis, MO), and S. M. COTE (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. refs

(ASME PAPER 83-GT-64)

A description is presented of the results from throttle usage analyses of the F/A-18A aircraft with F404-GE-400 engines. In 1975, the considered aircraft had been selected by the Navy to satisfy the new strike fighter requirement. There was concern regarding the reliability and durability of the F404 engine, and a number of investigations were conducted in this connection. Attention is given to usage prediction procedures, the Accelerated Service Test (AST) engine usage, AST mission segment comparisons, the projected F/A-18A transitional training engine usage, and parametric sensitivities. In the investigations, use was made of comprehensive, systematic procedures, which had been developed by an American aerospace company for predicting engine usage based on digital flight simulation programs and a significant flight data base. The obtained results show that these procedures provide a powerful tool for the considered applications. G.R.

**A83-47925#**

### **INVESTIGATION OF FIXED-RAKE SAMPLING SYSTEM FOR THE ASSESSMENT OF EMISSION CHARACTERISTICS OF GAS TURBINE ENGINES**

H. C. LOW (Rolls-Royce, Ltd., Combustion Dept., Bristol, England) and A. P. DOWLING (Cambridge University, Cambridge, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. refs

(ASME PAPER 83-GT-72)

The regulations proposed by the U.S. Environmental Protection Agency to limit the quantity of pollutant gases emitted by aircraft engines allow the exhaust of engines submitted for compliance testing to be sampled by a fixed-multipoint rake. However, the onus is placed on the manufacturer to prove the representativeness of the samples taken in this relatively cheap fashion. To illustrate best possible accuracies, the exhaust of an M45H civil turbofan engine has been extensively sampled and a computer program

has been used to select the optimum configuration of a cruciform rake. The program demanded excellent agreement between the sampling methods and this proved to be the case in actual tests. However, the program also indicates that the errors of a simply designed rake giving area-weighted samples would also be less than 10 percent. Sampling in the FAA diamond pattern would give rise to a 20 percent error in CO emissions. Author

#### A83-47926#

##### TEST EXPERIENCE WITH TURBINE-END FOIL BEARING EQUIPPED GAS TURBINE ENGINES

F. J. SURIANO (Garrett Turbine Engine Co., Phoenix, AZ), R. D. DAYTON (USAF, Wright Aeronautical Laboratory, Wright-Patterson AFB, OH), and F. G. WOESSNER (U.S. Naval Air Propulsion Test Center, Trenton, NJ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 6 p. refs  
(Contract F33615-78-C-2044; N00140-79-C-1294)  
(ASME PAPER 83-GT-73)

A development status report is presented for the application of gas-lubricated hydrodynamic journal foil bearings to the turbine end of gas turbine engines. Various designs of bearings of this type, developed through rig testing, have been incorporated into test engines for the evaluation of bearing and rotor system performance. The operational tests gave attention to engine thermal environment, endurance, start/stop behavior, attitude, environmental temperatures and pressures, and simulated maneuver bearing loads. O.C.

#### A83-47929#

##### EAGLE/DTA - A LIFE CYCLE COST MODEL FOR DAMAGE TOLERANCE ASSESSMENT

E. J. REED (United Technologies Corp., Government Products Div., West Palm Beach, FL) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 6 p.  
(ASME PAPER 83-GT-76)

The requirements, structure, and capabilities of a life cycle cost model developed to evaluate damage tolerance design under Phase I of the Life Cycle Cost/Damage Tolerance Assessment (LCC/DTA) program are discussed. The model is capable of predicting the influence of variations in expected usage on cost and is sensitive enough to evaluate design trade studies. The impact of these trades on maintenance practice and philosophy is also discussed. The completion of this phase of the LCC/DTA program is an important step in evaluating the relationship between damage tolerance design and maintenance requirements of gas turbine engines. The model provides the methodology necessary to assess the effect of damage tolerance design on weapon system cost and provides the tool necessary to minimize the life cycle cost of advanced aircraft systems. V.L.

#### A83-47934#

##### COMPARISON-EFFECTS OF BROADENED PROPERTY JET FUELS ON OLDER AND MODERN J79 COMBUSTORS

D. W. BAHR (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs  
(ASME PAPER 83-GT-81)

The results of parallel investigations to determine the impacts of jet fuel property variations on the performance, life, and pollutant emission characteristics of two different J79 engine combustor designs are compared. One of the designs embodies older technology features. The other design was developed more recently and embodies several advanced technology features to provide lower smoke levels and longer liner life capabilities. Both combustors were evaluated with the same set of thirteen fuels. The fuels were selected to provide fuel property ranges which span those of current jet fuels and of possible future broadened-specification jet fuels. The modern technology combustor was found to be considerably more tolerant of fuel property variations than the older technology design. The relative

insensitivity of the modern technology design is primarily attributed to its lean-burning features, which result in low smoke and low flame radiation levels even with low hydrogen content fuels.

Author

#### A83-47938#

##### A7E/TF41 ENGINE MONITORING SYSTEM (EMS)

L. R. DEMOTT (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p.  
(ASME PAPER 83-GT-91)

The U.S. Navy A7E is a single-engine, light attack aircraft with a TF41-A-2 engine. It was introduced into service in 1969. In 1970, the concept was initiated to utilize an on-board computer for monitoring the health of the engine, and a phased program was begun in 1971. The objectives of the TF41 EMS are related to a reduction of maintenance costs, an increase in aircraft availability, improved flight safety, and increased mission effectiveness. Attention is given to the engine kit, the EMS avionics kit, the engine analyzer unit, the data display unit, the airframe change kit, the data processing station, aspects of system/equipment mission and use, and program background and operating experience. G.R.

#### A83-47943#

##### AUTOMATED DIAGNOSTIC SYSTEM FOR ENGINE MAINTENANCE

F. FANUELE and R. A. RIO (Mechanical Technology, Inc., Latham, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 4 p. USAF-supported research.  
(ASME PAPER 83-GT-103)

The Automated Vibration Diagnostic System (AVID) developed for the U.S. Air Force jet engine overhaul centers is described. AVID automates troubleshooting procedures for fully assembled gas turbine engines. High-frequency vibration data are extracted from existing standard instrumentation to provide input to a specialized symptom/fault matrix. This matrix is configured to analyze the incoming data and to assign a particular malfunction (or malfunctions) to a specified data set. This diagnosis is printed out to provide maintenance personnel with precise knowledge of what the problem is and how to correct it. It is noted that AVID should enable the Air Force to significantly reduce expenses at the jet engine overhaul centers. B.J.

#### A83-47944#

##### THE NAVY PATE PROGRAM - A STATUS REPORT

L. GRECO (U.S. Naval Air Engineering Center, Lakehurst, NJ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p.  
(ASME PAPER 83-GT-109)

The Navy PATE (Propulsion Automatic Test Equipment) program was initiated in 1977 in an attempt to control the development, procurement, and implementation of computerized test equipment for testing Navy aircraft gas turbine engines and engine components. Software tools have been developed to enhance standardization of the use of the ATLAS language for engine test programs. The hardware systems delivered to fleet activities are all based on the Digital Equipment Corporation PDP 11/34 minicomputer. The philosophy utilized has been to add computer-based data acquisition systems as redundant systems to existing test cells. This paper describes the systems deployed to the fleet, the operating capabilities of these systems, and the experience gained. Projections for potential applications of current and planned systems are also included. Author

**A83-47950#**

## MEASUREMENT AND ANALYSES OF HEAT FLUX DATA IN A TURBINE STAGE. I - DESCRIPTION OF EXPERIMENTAL APPARATUS AND DATA ANALYSIS

M. G. DUNN, W. J. RAE (Calspan Advanced Technology Center, Buffalo, NY), and J. L. HOLT (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 5 p. refs

(Contract F33615-81-C-2017)

(ASME PAPER 83-GT-121)

The experimental apparatus, measurements performed, and data analysis procedure used to obtain detailed heat flux data for a full-stage rotating turbine are described. A shock tube was used as a short-duration source of heated air and miniature thin-film heat-flux gages were used to obtain detailed measurements on the component parts. The results indicate that the spatial temperature distribution does not significantly influence the heat transfer results. The effect of the temperature dependence of the thermal properties of the substrate on the inferred rates was analyzed, and it was determined that very small corrections had to be applied to the data for a temperature of 1000 R, while for 1600 R data, the corrections amounted to approximately 8 percent. C.D.

**A83-47951#**

## MEASUREMENT AND ANALYSES OF HEAT FLUX DATA IN A TURBINE STAGE. II - DISCUSSION OF RESULTS AND COMPARISON WITH PREDICTIONS

M. G. DUNN, W. J. RAE (Calspan Advanced Technology Center, Buffalo, NY), and J. L. HOLT (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs

(Contract F33615-81-C-2017)

(ASME PAPER 83-GT-122)

Full-stage heat flux data have been obtained under representative operating conditions for the nozzle guide vane (NGV), rotor, and shroud of the full-stage rotating turbine of the Garrett TFE-731-2 engine. For the NGV airfoil and rotor blade, the influence of wall temperature ratio on the Stanton number is shown to be generally 10 percent or less over the range of 0.53 to 0.21. The results suggest that the boundary layer transition occurs very early on the NGV suction surface and that the flow is generally turbulent on the rotor blade pressure and suction surface. C.D.

**A83-47958#**

## CASCADE FLUTTER ANALYSIS OF CANTILEVERED BLADES

A. V. SRINIVASAN (United Technologies Research Center, East Hartford, CT) and J. A. FABUNMI (Maryland, University, College Park, MD) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 10 p. refs

(ASME PAPER 83-GT-129)

A formulation of the cascade flutter problem is presented in such a way that the modal characteristics of individual blades that may be available from a detailed finite element analysis or from direct experimental measurement can be used. The flow conditions may also vary along the span. The considerations taken into account include coupling between the torsional and bending degrees of freedom at each spanwise location of the blade, coupling among blade modes through either aerodynamic or mechanical means, individual blade modal characteristics, and unsteady aerodynamic coefficients, and blade-to-blade differences in either frequency or damping or both. A complex eigenvalue problem results which is solved for an assumed analysis frequency, a proper choice of which leads to solution in which the computed eigenfrequency matches the assumed analysis frequency. The nature of the eigenvalues establishes the extent of susceptibility to an aeroelastic instability. C.D.

**A83-47959#**

## BLADE VIBRATION MEASUREMENTS ON CENTRIFUGAL COMPRESSORS BY MEANS OF TELEMETRY AND HOLOGRAPHIC INTERFEROMETRY

U. HAUPT and M. RAUTENBERG (Hannover, Universitaet, Hanover, West Germany) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. Research supported by the Deutsche Forschungsgemeinschaft and Forschungsvereinigung Verbrennungskraftmaschinen.

(ASME PAPER 83-GT-131)

Blade vibration measurements have been carried out on a high-pressure, high mass-flow centrifugal compressor to determine the excitation mechanism. For the experimental investigation, semiconductor strain gages with a multichannel telemetry system were used. The measuring points on the blades have been chosen using the results of a stress calculation for the vibrating blade by means of the FE-method. A research program was started with blade vibration measurements in different operating ranges of the compressor and with two types of diffusers. Results are presented for the blade excitations obtained by throttling the compressor at various rotational speeds and for the cases of passing resonances by increasing the rotational speed at constant throttle valve position. Results were obtained for blade excitations caused by: (1) the nonuniformity of the flow in the diffuser, (2) the stalled flow near the surge-line, (3) the blades of a vaned diffuser, and (4) the surge. The investigations have been completed by optical measurements to find out the vibrational modes of the different blades in rotating operation. These tests were carried out by means of a holographic interferometric system using an optical derotator up to a rotational speed of  $n = 20,500$  rpm. Author

**A83-47960#**

## STRUCTURAL RESPONSE DUE TO BLADE VANE INTERACTION

R. L. JAY, D. W. BURNS (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN), and J. C. MACBAIN (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p.

(Contract F33615-79-C-2045)

(ASME PAPER 83-GT-133)

The structural response of a bladed turbine disk due to excitation from an upstream stator row was measured using strain gages. Rig testing performed in a realistic aerodynamic environment was preceded by a static vibratory search in which individual blade frequencies and system modes were identified by strain response and holography. In the rig testing special emphasis was placed on identifying the dynamic response resulting from the interaction between the vanes and blades. An analytical description of the forcing function which results from the difference between the number of blades and the number of vanes is presented and correlated with detailed blade responses both in terms of amplitude and interblade phasing. In particular, the combination of 26 inlet vanes and the 30 rotor blades yielded strong dynamic responses in two modes of the four diametral family. The experimental results augmented by the analytical formulation of excitation created by the difference in vane and blade numbers have conclusively identified a mechanism for large blade dynamic response which should be considered in the design phase of bladed disk systems. Author

**A83-47963#**

## THE IMPACT OF THREE-DIMENSIONAL ANALYSIS ON FAN DESIGN

D. R. CLEMMONS, P. R. DODGE, and W. L. BLACKMORE (Garrett Turbine Engine Co., Phoenix, AZ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 6 p. refs

(ASME PAPER 83-GT-136)

During the last few years, great advances have been made regarding the techniques for the numerical simulation of flows in



turbomachinery blade rows. However, the developed two-dimensional procedures were restricted in transonic rotors by the three-dimensional nature of the flow passage. The present investigation has been concerned with the development of a three-dimensional transonic relaxation technique. This development is to provide a basis for the analysis of transonic fan stages in a manner analogous to the successful cascade two-dimensional analysis techniques. The developed technique takes into consideration a potential equation derived by Dodge and Lieber (1978) and the solution of this equation by a transonic relaxation technique, which was also described by Dodge and Lieber. The first application of the new technique is related to the design of transonic fans for business aircraft engines. G.R.

**A83-47964\*#** United Technologies Research Center, East Hartford, Conn.

**A VORTEX VENTURI FOR REVERTING ANTIMISTING FUEL PROPERTIES**

E. J. SZETELA and J. TEVELDE (United Technologies Research Center, East Hartford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. (Contract NAS3-22045)

(ASME PAPER 83-GT-137)

The level of degradation of antimisting fuel polymers such as FM-9 which must be accomplished in order to use antimisting fuel in existing engines may require the use of cavitation. The hydrodynamic shear produced by the collapse of vapor bubbles is capable of producing more splitting of polymeric molecules than mechanically-induced shear. A program has been carried out to investigate the possibility of using a cavitating venturi with rotating flow as a fuel reverter. This investigation included the effects of a swirl-inducing twisted tape upstream of the throat, inlet pressure, recovery pressure ratio and a pintle for varying throat area. A correlation of the data was produced, system concepts for using the vortex venturi were investigated and problem areas were delineated. Author

**A83-47966#**

**EMISSIONS VARIABILITY AND TRAVERSING ON PRODUCTION RB211 ENGINES**

H. L. HAWKINS, J. K. BHANGU, C. H. PRIDDIN, and P. H. WALKER (Rolls-Royce, Ltd., Derby, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. FAA-supported research. refs

(ASME PAPER 83-GT-141)

Firm proposals for an emission certification scheme for aircraft gas turbines have been made by the ICAO and the U.S. Environmental Protection Agency (EPA). Although rules for sample transfer and analysis methods have been clearly defined, the emissions measurements will be subject to variability. The causes for such a variability are related to engine-to-engine variability, sampling variation because of the nonuniform distribution of the pollutant species in the exhaust plane, and gas analysis instrumentation scatter. The present investigation is concerned with studies which have been conducted regarding the first two causes for variability. The third source of variability is much smaller than the other two. The exhaust emissions on six RB211-524B-02 engines were measured using a fixed forty-hole cruciform rake. A very comprehensive study of the pollutant distribution across the exhaust plane of an engine was also performed. G.R.

**A83-47967#**

**AIRCRAFT USAGE AND EFFECTS ON ENGINE LIFE**

J. F. MONTGOMERY, III, T. R. SEWALL (General Electric Co., Cincinnati, OH), and J. J. BATKA (USAF, Wright-Patterson AFB, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. refs

(ASME PAPER 83-GT-143)

'Engine Life' in the field environment is defined as the total interval of operation which engines remain in service on the aircraft.

The numbers of engines removed, divided by the flight time, defines the total 'shop visit rate'. The present investigation is mainly concerned with the usage-life related area of shop visit rates. It is shown that these shop visit rates depend on usage, which, in turn, is determined by aircraft characteristics and mission utilization. In particular, it is found that engine life functions are significantly affected by aircraft mission power usage. Aircraft power usage, on the other hand, is significantly affected by the aircraft power loadings, power margins, and operational handling constraints.

G.R.

**A83-47969#**

**SUBSTRUCTURING AND WAVE PROPAGATION - AN EFFICIENT TECHNIQUE FOR IMPELLER DYNAMIC ANALYSIS**

R. HENRY and G. FERRARIS (Institut National des Sciences Appliquees, Villeurbanne, Rhone, France) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. Research supported by the Fives Cail-Babcock. refs

(ASME PAPER 83-GT-150)

The existing methods of the dynamic analysis of rotating components and, in particular, bladed disk assemblies are briefly reviewed, and a new method is proposed for computing the frequencies and mode shapes of repetitive structures. The approach proposed here combines the advantages of the substructure technique and that of wave propagation in periodic systems. The mode shapes and frequencies are obtained from the analysis of a single repetitive sector of the structure using the finite element method. The application of the method to a centrifugal compressor impeller is reported, along with experimental verification of the computed results. V.L.

**A83-47970\*#** Lehigh Univ., Bethlehem, Pa.

**ANALYSIS OF AN AXIAL COMPRESSOR BLADE VIBRATION BASED ON WAVE REFLECTION THEORY**

J. A. OWCZAREK (Lehigh University, Bethlehem, PA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p.

(Contract NAG3-135)

(ASME PAPER 83-GT-151)

The paper describes application of the theory of wave reflection in turbomachines to rotor blade vibrations measured in an axial compressor stage. The blade vibrations analyzed could not be predicted using various flutter prediction techniques. The wave reflection theory, first advanced in 1966, is expanded, and more general equations for the rotor blade excitation frequencies are derived. The results of the analysis indicate that all examined rotor blade vibrations can be explained by forced excitations caused by reflecting waves (pressure pulses). Wave reflections between the rotor blades and both the upstream and downstream stator vanes had to be considered. Author

**A83-47981#**

**EFFECTS OF STATIC FRICTION ON THE FORCED RESPONSE OF FRICTIONALLY DAMPED TURBINE BLADES**

J. H. GRIFFIN (Carnegie-Mellon University, Pittsburgh, PA) and A. SINHA American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 5 p. refs

(Contract AF-AFOSR-82-0134)

(ASME PAPER 83-GT-155)

The effect of static friction on the design of flexible blade-to-ground vibration dampers used in gas turbine engines is investigated. It is found that for gamma (ratio of dynamic and static friction coefficients) less than 1, the steady-state response is essentially harmonic when the damper slip load, S, is small. However, as S increases beyond a certain value, the steady-state response ceases to be simply harmonic and, while still periodic, is a more complex waveform. The transition slip load is found to be lower for smaller gamma. The maximum possible reduction in vibratory stresses increases as gamma decreases. These analytical results are compared with those from the conventional numerical

time integration method. In addition, an efficient time integration algorithm is described which can be used to predict the peak displacements of the transition solution without tracing the whole waveform, a useful procedure when no harmonic steady-state solution exists. The conditions under which blade response can be adequately modeled by simulating only dynamic friction are established. Author

### **A83-47984# DEVELOPMENTS IN AIR COOLING OF GAS TURBINE VANES AND BLADES**

D. E. METZGER (Arizona State University, Tempe, AZ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 6 p. refs  
(ASME PAPER 83-GT-160)

Increases in the performance of a gas turbine thrust propulsion engine as indicated by the fuel consumption per pound of thrust are considered. It is found that current engine technology is approaching fifty percent of the original fuel consumption levels. An important factor contributing to the efficiency improvement has been an increase in the operating temperatures. Possibilities for such an increase have been provided by developments in materials technology and advances related to the technology of cooling components exposed to the high temperature gases. Aspects of current airfoil cooling practice are considered along with examples of current cooling passage performance studies, and procedures of formal design optimization. G.R.

### **A83-47992# BUILT-IN TEST EQUIPMENT (BITE) ON THE GARRETT MODEL GTCP331 APU DIGITAL ELECTRONIC CONTROL UNIT**

S. R. LACROIX and R. F. STOKES (Garrett Turbine Engine Co., Phoenix, AZ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p.  
(ASME PAPER 83-GT-186)

Developments related to digital electronic controls with decision-making capabilities and the desire to improve maintenance have led to the incorporation of Built-In-Test-Equipment (BITE) in the electronic control system of the latest gas turbine auxiliary power unit (APU). BITE has been designed to help isolate defective components and display the obtained information. A microprocessor based electronic control unit (ECU) was selected to control the APU. Attention is given to an APU description, the design philosophy for BITE, the BITE test modes, the three basic types of tests conducted by the digital computer, the annunciation of BITE or fault information, and the extension of APU operation by the BITE system. G.R.

### **A83-47993# THE IMPACT OF COMPUTERS ON THE TEST CELL OF TOMORROW**

C. F. ASH (Aero Systems Engineering, Inc., St. Paul, MN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p.  
(ASME PAPER 83-GT-187)

The role that computers are to play in engine testing is outlined. It is noted that although the adoption of completely automated closed-loop test cells has been slower than expected, economic pressures and technological advances will combine to make closed-loop testing the standard approach in the years to come. Among the benefits will be better overall management of the engine test program, more consistent and reliable data, more effective use of personnel and equipment, and lower costs. The successful application of a real-time computer system with both open-loop and closed-loop capabilities is discussed. This particular system, the Automatic Data Acquisition and Processing System, managed its first 3000 hours of engine operation without a single hardware or software interruption. C.R.

### **A83-47994# THE GTCP331, A 600 HP AUXILIARY POWER UNIT PROGRAM**

L. M. STOHLGREN (Garrett Turbine Engine Co., Phoenix, AZ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 12 p.  
(ASME PAPER 83-GT-188)

The considered GTCP331 series auxiliary power unit (APU) provides a complete range of pneumatic and electrical power for the emerging generation advanced transport category aircraft. The services of the APU are related to the main engine start, cabin air conditioning, the supply of compressed air to the aircraft wing deice system, miscellaneous pneumatic applications, and the supply of electric power. Attention is given to aspects of installation, the APU capabilities, a detailed description of the APU, a simplified surge control system, the development program, and the qualification program, including the qualification test matrix. G.R.

### **A83-47995# EMERGENCY POWER FOR THE F-16 AIRCRAFT**

D. V. ALLEN, A. C. STANCLIFFE (AiResearch Manufacturing Co., Torrance, CA), and O. W. WHITE (General Dynamics Corp., Fort Worth, TX) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 5 p.  
(ASME PAPER 83-GT-189)

The emergency power unit (EPU) for the General Dynamics F-16 'Fighting Falcon' aircraft provides electrical and hydraulic power in the event of main engine generator or hydraulic pump failure or an engine-out condition. The unit is powered by main engine bleed air, or by the decomposition products of H-70 fuel (a hydrazine-water mixture), or a combination of both. This paper describes the emergency power unit and discusses the use of H-70 on the flight line. Author

### **A83-47998# EMISSIONS FROM ENCLOSED SWIRL STABILISED PREMIXED FLAMES**

N. T. AHMAD and G. E. ANDREWS (Leeds University, Leeds, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. Research supported by the Science and Engineering Research Council. refs  
(ASME PAPER 83-GT-192)

The premixed combustion efficiency and emissions characteristics of four axial vane swirlers are compared with a simple grid plate stabilized premixed flame. The four swirlers are designed to investigate the influence of swirl number, pressure loss and swirler design. The results show that efficient combustion of weak mixtures at simulated gas turbine combustion conditions is difficult with swirl systems, but relatively easily achieved with grid plate systems. High swirl numbers are shown to have the worst combustion efficiency with a major unburned hydrocarbon problem. NO(x) emissions are similar for all the stabilizers and they all exhibit a very high proportion of NO<sub>2</sub> and NO(x) emissions for weak mixtures. Author

### **A83-47999# INTEGRATED FLIGHT AND PROPULSION OPERATING MODES FOR ADVANCED FIGHTER ENGINES**

H. BROWN and W. S. FISK (General Electric Co., Cincinnati, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p.  
(ASME PAPER 83-GT-194)

This paper presents the results of preliminary studies of advanced propulsion system requirements and capabilities for the next generation of fighter aircraft. It represents an examination of current and advanced concepts of internal variable engine geometry and advanced exhaust system concepts for use in expanding the role of the propulsion system in the flight process. Special engine operating modes are defined and their potential capabilities are

described. In-flight thrust vectoring and reversing concepts are described and their use in providing propulsive pitch and yaw forces for flight control assist are discussed. Potential control concepts and requirements for implementing the advanced engine operating modes are also described. Author

**A83-48000\*#** General Electric Co., Lynn, Mass.  
**STATUS REPORT - DARPA/NASA CONVERTIBLE TURBOFAN/TURBOSHAFT ENGINE PROGRAM**  
 A. I. BELLIN and A. BROOKS (General Electric Co., Aircraft Engine Business Group, Lynn, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 6 p.  
 (Contract NAS3-22752)  
 (ASME PAPER 83-GT-196)

A development status report is presented for the NASA/Defense Advanced Research Projects Agency convertible turbofan-turboshaft engine, which can power a high speed rotorcraft in vertical flight, as well as in horizontal flight up to speeds of Mach 0.85. The basis for this development program is a modified TF34-GE-400 engine. Program objectives include both the demonstration of dual output mode (jet thrust and shaft horsepower) capability and the development of a control system which will operate the engine in either mode and convert operation between the modes. O.C.

**A83-48001#**  
**A COMPARISON OF NAVY AND CONTRACTOR GAS TURBINE ACQUISITION COST**  
 L. T. FINIZIE (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 5 p. refs  
 (ASME PAPER 83-GT-198)

An investigation is conducted concerning the reasons for differences between Navy and contractor gas turbine costs. Attention is given to life cycle cost criteria, Navy development costs, a development cost comparison, production costs, and a production costs comparison. It is found that the cost differences are primarily related to the employment of different methods for the determination of the cost. Emphasis on lower operating and support costs will lead to the conduction of more tests to develop a more reliable engine than obtained in previous developments. This difference with respect to engine requirements would cause an increase in development costs. G.R.

**A83-48002\*#** General Dynamics Corp., Fort Worth, Tex.  
**A DESIGN STUDY OF A REACTION CONTROL SYSTEM FOR A V/STOL FIGHTER/ATTACK AIRCRAFT**  
 B. B. BEARD and W. H. FOLEY (General Dynamics Corp., Fort Worth, TX) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 6 p. refs  
 (Contract NAS2-10981)  
 (ASME PAPER 83-GT-199)

Attention is given to a short takeoff vertical landing (STOVL) aircraft reaction control system (RCS) design study. The STOVL fighter/attack aircraft employs an existing turbofan engine, and its hover requirement places a premium on weight reduction, which eliminates prospective nonairbreathing RCSs. A simple engine compressor bleed RCS degrades overall performance to an unacceptable degree, and the supersonic requirement precludes the large volume alternatives of thermal or ejector thrust augmentation systems as well as the ducting of engine exhaust gases and the use of a dedicated turbojet. The only system which addressed performance criteria without requiring major engine modifications was a dedicated load compressor driven by an auxilliary power unit. O.C.

**A83-48003#**  
**PROPULSION SYSTEM SCREENING FOR SURVIVABILITY AND EFFECTIVENESS**  
 H. MONTAGUE (Grumman Aerospace Corp., Bethpage, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 11 p.  
 (ASME PAPER 83-GT-200)

In view of the need in advanced military aircraft design for an evaluation of propulsion systems, in a combat scenario, that will discriminate according to the cost of performing the required mission, methods are presented which can be employed in the course of parametric studies to screen candidate design options and identify trends and design drivers. The analyst thereby gains the ability to assess survivability and vulnerability characteristics upon selection of the engine and propulsion system configuration for a given mission task in terms of a cost-related figure of merit. A recent study concerning propulsion survivability and weapon system design is used as an illustration of the method. A modest redesign of the aircraft reduced its combat cost by a factor of 60. O.C.

**A83-48005#**  
**THE MEASUREMENT OF TURBOMACHINERY STATOR-TO-DRUM RUNNING CLEARANCES**  
 D. P. DAVIDSON (Rotadata, Ltd., Derby, England), R. D. DEROSE, and A. J. WENNERSTROM (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 5 p.  
 (ASME PAPER 83-GT-204)

A relatively simple technique is described which makes it possible to measure the stator-tip-to-drum clearance actively during engine or component operation. The technique uses a device originally intended for the measurement of rotor tip and shroud running clearances. The installation and operation of the system is discussed, and results of vane-to-drum measurements made on a research compressor are presented. The same basic concept should be applicable to measurements of similar types of clearances in a turbine stage or in labyrinth seals under shrouded stators or even buried deeper within an engine. V.L.

**A83-48008#**  
**EXPERIMENTAL INVESTIGATION OF FUEL DISTRIBUTION IN A TRANSVERSE STREAM**  
 M.-L. YANG, S.-J. GU, G.-E. LIU, and X.-Y. LI (Beijing, Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. refs  
 (ASME PAPER 83-GT-207)

Results are presented for an experimental study of the distribution of fuel downstream from a plain orifice injector in a transverse air stream. The fuel concentration distribution at the survey plane downstream of the injector is found using an iso-kinetic sampling method, and the pattern of the fuel distribution is examined. Empirical expressions are derived for the centerline of a fuel spray and for the peak value of the fuel concentration. An empirical method is developed in order to predict the liquid fuel concentration distribution in the plane downstream from the injector and the fuel dispersion contour line. N.B.

**A83-48013#**

## **VECTORIZING EXHAUST SYSTEMS FOR STOL TACTICAL AIRCRAFT**

R. F. TAPE (Rolls-Royce, Inc., Atlanta, GA), W. R. HARTILL (Rockwell International Corp., Los Angeles, CA), S. CURRY (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH), and T. J. JONES (Rolls-Royce, Ltd., Bristol, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 11 p. (ASME PAPER 83-GT-212)

Four different STOL tactical aircraft propulsion system configurations that incorporate novel nozzle concepts are presently considered, in order to produce the glide slope equilibrium needed for operation from 700-1000 foot long fields in distinct ways. The canard configuration CTOL baseline design is reconfigured in this study to operate with aerodynamically balanced deflected thrust, vectored fan thrust, jet balanced deflected thrust, and vectored total thrust. The nozzle concepts invoked are those of a vectoring axisymmetric convergent side nozzle, a vectoring side nozzle with variable ramp, a deflecting two-dimensional convergent-divergent nozzle, and a counter-rotating duct and thrust-reversing balanced piston nozzle. STOL is demonstrated by these means with little penalty in weight and cost and with no loss in mission capability.

C.O.

**A83-48016#**

## **A THREE-DIMENSIONAL MODEL FOR THE PREDICTION OF SHOCK LOSSES IN COMPRESSOR BLADE ROWS**

A. J. WENNERSTROM and S. L. PUTERBAUGH (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 5 p. refs

(ASME PAPER 83-GT-216)

A design trend evident in newly evolving aircraft turbine engines is a reduction in the aspect ratio of blading employed in fans, compressors, and turbines. As aspect ratio is reduced, various three-dimensional flow effects become significant which at higher aspect ratios could safely be neglected. This paper presents a new model for predicting the shock loss through a transonic or supersonic compressor blade row operating at peak efficiency. It differs from the classical Miller-Lewis-Hartmann normal shock model by taking into account the spanwise obliquity of the shock surface due to leading-edge sweep, blade twist, and solidity variation. The model is evaluated in combination with two test cases. Each was a low-aspect-ratio transonic stage which had exceeded its efficiency goals. Use of the revised shock loss model contributed 2.11 points to the efficiency of the first test case and 1.08 points to the efficiency of the second.

Author

**A83-48018#**

## **A PRELIMINARY STUDY OF ANNULAR DIFFUSERS WITH CONSTANT DIAMETER OUTER WALLS (SUITABLE FOR TURBINE EXITS)**

R. C. ADKINS (Cranfield Institute of Technology, Cranfield, Beds., England), O. H. JACOBSEN, and P. CHEVALIER American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. refs (ASME PAPER 83-GT-218)

The results of a series of tests conducted on annular diffusers with constant-diameter outer casings, that are typical of turbine exits, are presented. It is shown that the maximum pressure recovery is achieved at a distance of four centerbody diameters downstream of the cylinder/closure-cone junction. When the ratio of inlet diameters,  $r_1$ , is less than about 0.42, the level of the ultimate pressure recovery is insensitive to the centerbody design. However, when  $r_1$  exceeds 0.42, the pressure recovery becomes increasingly dependent on the centerbody design. Test data are presented in graphical form.

V.L.

**A83-48029#**

## **F-14 AIRCRAFT AND PROPULSION CONTROL INTEGRATION EVALUATION**

W. J. DAVIES (United Technologies Corp., Government Products Div., West Palm Beach, FL), C. A. HOELZER (Grumman Aerospace Corp., Bethpage, NY), and R. W. VIZZINI (U.S. Naval Air Propulsion Test Center, Trenton, NJ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 10 p. refs (ASME PAPER 83-GT-234)

An integration evaluation is presented for a fault-tolerant, full authority digital electronic control (FADEC) in an F-14 aircraft, and the benefits of the FADEC/F-14 integrated system are discussed. The control of the advanced fuel management system incorporated into the overall system is addressed, as are the flight propulsion control system integration, the inlet and engine airflow matching, stall detection and recovery, and improved cruise fuel consumption.

C.D.

**A83-48173**

## **AN HISTORICAL REVIEW OF PROPELLER DEVELOPMENTS**

R. M. BASS (Dowty Rotol, Ltd., Gloucester, England) Aeronautical Journal (ISSN 0001-9240), vol. 87, Aug.-Sept. 1983, p. 255-267. refs

The stages in the historical development of air and water propellers are reviewed, with a focus on British variable-pitch aircraft propellers perfected after World War I. The earliest references to propeller-like devices are considered, and the beginnings of modern marine-propeller design in the 18th and 19th centuries are characterized. The technology of variable-pitch airplane propeller hubs is illustrated with detailed cross-section drawings, mainly from the 1940's and 1950's. The use of advanced materials such as fiber-reinforced composites and its effects on hub design in modern propellers is discussed.

T.K.

**A83-48174**

## **SAVING FUEL WITH THE WIDE-CHORD FAN**

J. CUNDY (Rolls-Royce, Ltd., Derby, England) Aeronautical Journal (ISSN 0001-9240), vol. 87, Aug.-Sept. 1983, p. 272-276.

The wide-chord compressor fan developed for use in the 545E4 jet engine for the Boeing 757 beginning in 1984 is characterized. The design parameters include diameter = 188 cm, pressure ratio = 1.6-1.8, air flow = 523 kg/sec, and blade-tip speed = Mach 1.5. The blade chord is increased by one half relative to previous fans, allowing the number of blades to be reduced from 33 to 22 and midblade snubbers to be eliminated. A lightweight construction consisting of Ti-alloy plates jointed to a Ti-alloy honeycomb core by activated diffusion bonding is employed. Aerodynamic, strength, fatigue-strength, blade-retention, and bird-ingestion tests have been successfully completed, and the fan has been shown to contribute about 4 percent to the 10-percent overall fuel savings achieved by the 545E4.

T.K.

**A83-48215\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

## **SUBSONIC/SUPERSONIC AEROPROPULSIVE CHARACTERISTICS OF NONAXISYMMETRIC NOZZLES INSTALLED ON AN F-18 MODEL**

F. J. CAPONE (NASA, Langley Research Center, Transonic Aerodynamics Div., Hampton, VA), B. L. HUNT (Northrop Corp., Hawthorne, CA), and G. E. POTH (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) Journal of Aircraft (ISSN 0021-8669), vol. 20, Oct. 1983, p. 853-858. refs

Previously cited in issue 19, p. 3266, Accession no. A81-40878

**A83-48331#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**DESIGN CONCEPTS FOR LOW COST COMPOSITE ENGINE FRAMES**

C. C. CHAMIS (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 16 p.

(AIAA PAPER 83-2445)

Design concepts for low-cost, lightweight composite engine frames were applied to the design requirements for the frame of commercial, high-bypass turbine engines. The concepts consist of generic-type components and subcomponents that could be adapted for use in different locations in the engine and to different engine sizes. A variety of materials and manufacturing methods were assessed with a goal of having the lowest number of parts possible at the lowest possible cost. The evaluation of the design concepts resulted in the identification of a hybrid composite frame which would weigh about 70 percent of the state-of-the-art metal frame and cost would be about 60 percent. Author

**A83-48341#**

**THE PROSPECTS AND POTENTIAL OF ALL ELECTRIC AIRCRAFT**

M. J. CRONIN (Lockheed-California Co., Burbank, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 10 p. refs

(AIAA PAPER 83-2478)

It is pointed out that the concept and design/production of all electric aircraft go as far back as World War II. The main objective for the design of such aircraft was to take advantage of the simple and clean installation afforded by electric power systems. Another reason involved the elimination of a fire hazard due to the presence of oil. The hydraulic system is currently a major element of the aircraft's secondary power system. However, problems concerning the suitability of hydraulic systems for the next generation aircraft appear to arise. The present investigation is, therefore, concerned with the feasibility to employ electric power systems. Attention is given to secondary power systems, the flight control system, the environmental control system, propulsion systems, aspects of electric/electronic technology relevance, the next generation aircraft, and the advantages of an all electric aircraft. G.R.

**A83-48342#**

**ADVANCED COMMERCIAL ENGINES FOR THE 1990'S**

R. L. STAUBACH (United Technologies Corp., Pratt and Whitney Aircraft, East Hartford, CT) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 6 p.

(AIAA PAPER 83-2479)

Attention is given to the prospective design features of the 'third generation' turbofan engines that are to be developed for commercial aircraft use in the 1990s. Component technology advancements which may be integrated in the new designs include advanced airfoils, active blade tip clearance control, short, low loss burner designs, directionally solidified and single crystal turbine blade castings, and powder metallurgy disks. The configurations for the 1983-certification 30,000-45,000 lb thrust PW 2037 and 1986-certification 48,000-65,000 lb thrust PW 4000 turbofan engines are presented. Also noted are the efficiency improvements obtainable through 'propfan' turboprop technology, especially in the 90-110 seat aircraft market. O.C.

**A83-48343#**

**PRELIMINARY DESIGN ENGINE THERMODYNAMIC CYCLE SELECTION FOR ADVANCED FIGHTERS**

J. R. SIMMONS (General Electric Co., Evendale, OH) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 8 p.

(AIAA PAPER 83-2480)

Candidate thermodynamic cycles are selected during the preliminary design phase of an advanced fighter aircraft's turbofan

engine by means of a technique that defines a family of engine cycles with respect to component technology, operating limits, and component matching criteria. Engine family cycle variables are reduced to a matrix of compatible combinations from which those candidates most closely approximating aircraft performance requirements are chosen for further evaluation. A basis for technology evaluation is also furnished, through the comparison of engine matrices generated by technology level variations exclusively. The technique highlights the importance of thrust ratios, design flight Mach numbers, and airflow schedules for individual aircraft application, in the iteration process used to arrive at a final engine selection. O.C.

**A83-48358#**

**A NEW EJECTOR CONCEPT FOR V/STOL AIRCRAFT**

C.-W. CHU, V. M. ORTIZ, and T. C. WIDYNSKI (Northrop Corp., Aircraft Div., Hawthorne, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 6 p. refs

(AIAA PAPER 83-2514)

A new ejector concept for V/STOL aircraft applications is presented. In this concept a swirling motion is introduced into the primary flow issuing from a rectangular nozzle of a moderate aspect ratio; this combination of swirl and rectangular geometry produces enhanced mixing and entrainment in the rectangular mixing shroud. Enhanced mixing leads to better ejector pumping and shorter mixing shroud - both are desirable features for V/STOL applications. A series of water tunnel tests using a subscale plexiglass ejector model was conducted to demonstrate the potential of this concept through flow visualization and secondary weight-flow measurement. The results are presented and discussed. Author

**A83-48824**

**NON-UNIFORM FLOWS IN AXIAL COMPRESSORS DUE TO TIP CLEARANCE VARIATION**

J. H. HORLOCK (Open University, Milton Keynes, Bucks., England) and E. M. GREITZER (MIT, Cambridge, MA) Institution of Mechanical Engineers, Proceedings, Part C Mechanical Engineering Science (ISSN 0263-7154), vol. 197, Sept. 1983, p. 173-178. refs

(Contract F49620-82-K-0002)

An approximate analysis is presented for the asymmetric velocity nonuniformities that can exist in an axial compressor due to variations in tip clearance around the circumference. Calculations have been carried out for several different compressor configurations, as well as for both rotating (fixed to rotor) and stationary clearance variations. The numerical results show that, for a given compressor, the ratio of (percent) variation in axial velocity to (percent) variation in pressure rise coefficient due to asymmetric clearance increases as flow decreases, although this trend is not necessarily true for the magnitude of actual velocity nonuniformity. In addition, the velocity nonuniformity due to a rotating clearance can be substantially larger than that due to a stationary clearance. Author

**A83-49580#**

**HIGH SPEED PROPELLER FOR THE LEAR FAN 2100**

I. J. GILCHRIST (Lear Fan, Ltd., Reno, NV) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 10 p.

(AIAA PAPER 83-2465)

The design of the propeller for the Lear Fan 2100 high performance business airplane is described. The airplane has a single pusher propeller driven by the combined power of two turboshaft engines. The objective was to obtain an acceptable compromise between take-off thrust and cruise efficiency from a propeller with high disk loading and high tip helical Mach number. A four blade, 165 activity factor Kevlar composite propeller was developed in a joint program between Lear Fan and Hartzell Propeller Products. Blade planform, thickness, camber and twist were optimized using a strip theory computer program. A new type of airfoil was employed which combines high lift-to-drag ratio in cruise with high maximum lift during take-off. Analytical and

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flight test results indicate that performance objectives were closely met. Author

**A83-49581\*#** TRW, Inc., Redondo Beach, Calif.  
**THE DEVELOPMENT OF A GENERALIZED ADVANCED PROPELLER ANALYSIS SYSTEM**  
L. GLATT, J. KOSMATKA, R. SWIGART, E. WONG, D. CRAWFORD (TRW Inc., Space and Technology Group, Redondo Beach, CA), and H. NEUMANN (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 20 p. refs  
(Contract NAS3-22251)  
(AIAA PAPER 83-2466)

A Generalized Advanced Propeller Analysis System (GAPAS) is being developed to provide both an optimized design and a performance evaluation capability. The technology areas incorporated in GAPAS include propeller aerodynamic performance, airfoil loading, acoustics, structural analysis and aeroelasticity. The propeller analyses include the most advanced, fully-developed technologies in a modular but unified system. The program will treat multi-bladed propellers having straight or swept blades operating on aircraft at speeds to Mach 0.8 and altitudes to 40,000 feet. The purpose of this paper is twofold. First, it will introduce the GAPAS program to the general industry; and second, since the GAPAS program will be made available for general applications, it is also intended to be a status report on the development stage of the program. Author

**A83-49595\*#** Lockheed-California Co., Burbank.  
**INTEGRATED FLIGHT/PROPULSION CONTROL SYSTEM ARCHITECTURES FOR A HIGH SPEED AIRCRAFT**  
L. H. BANGERT, K. R. HENKE (Lockheed-California Co., Burbank, CA), R. J. GROMMES (Honeywell Systems and Research Center, Minneapolis, MN), and W. B. KERR (United Technologies Corp., Government Products Div., West Palm Beach, FL) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 8 p.  
(Contract NAS1-16869)  
(AIAA PAPER 83-2563)

The present investigation is concerned with the impact of integrated flight, inlet, and engine control system architectures on system effectiveness and life cycle cost (LCC). The aircraft employed in the investigation is a modified YF-12 with a cruise Mach number of 2.5. The aircraft has two advanced technology aircraft JT-69 afterburning, low-bypass turbofan engines. Advanced technologies suitable for use in future flight/propulsion control systems are related to distributed computer networks, fault tolerant computers and software, analytical redundancy, self-checking microprocessor pairs, advanced direct drive actuators, fiber optic data buses, VLSI microcircuits, and skewed sensors. The integrated architectures were found to have fewer sensors, actuators, and power sources than the nonintegrated architectures. G.R.

**A83-49597\*#**  
**SUPERSONIC V/STOL - TANDEM FAN CONCEPTS**  
D. E. GRIFFIN (United Technologies Corp., West Palm Beach, FL) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 8 p. Navy-supported research.  
(AIAA PAPER 83-2567)

Only two V/STOL aircraft have reached operational use, including the British (and U.S.) Harrier (AV-8A) and the Soviet Forger aircraft. Major problems limiting the operational use of V/STOL aircraft are related to aircraft and propulsion system compromises which have been necessary. The tandem fan V/STOL concept offers a new approach to reduce the V/STOL penalties in a supersonic fighter/attack aircraft. The present investigation is concerned with a preliminary design of the gas turbine engine for the tandem fan concept. Attention is given to the basic principles of the tandem fan concept, the blocker valve design, the front burner design, front nozzle concepts, the rear nozzle, the tandem

fan cross section, the turbomachinery characteristics, and a critical components and technology assessment. G.R.

**A83-50115**  
**DIRECT-CURRENT POWER SUPPLY UNITS GVG 800/350 [GLEICHSTROMVERSORGUNGSGERAETE GVG 800/350]**  
W.-D. KROHS (Interflug Gesellschaft fuer Internationalen Flugverkehr mbH, Berlin, East Germany) Technisch-oekonomische Information der zivilen Luftfahrt (ISSN 0232-5012), vol. 19, no. 2, 1983, p. 41, 42, 46. In German.

During the years 1981 and 1982 a number of power supply systems were designed for the airports and workshops of Interflug, the airline of the German Democratic Republic. The present investigation is concerned with the dc power-supply units GVG 350 and GVG 800, which were designed in connection with the considered program. Both units provide a dc voltage of 28 V, corresponding to the voltage of a charged lead-acid storage battery. The GVG 350 units represent a new development for supplying on the ground small and medium-sized aircraft and helicopters of Interflug with electric power. The GVG 800 are intended for larger aircraft. They are replacing the power-supply units SVG 600 and SVG 800 with a comparative rating. G.R.

**N83-34941\*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.  
**EFFECTS OF PERCENTAGE OF BLOCKAGE AND FLAMEHOLDER DOWNSTREAM COUNTERBORES ON LEAN COMBUSTION LIMITS OF PREMIXED, PREVAPORIZED PROPANE-AIR MIXTURE**  
M. A. B. FERNANDEZ Sep. 1983 11 p refs  
(NASA-TP-2227; E-1588; NAS 1.60:2227) Avail: NTIS HC A02/MF A01 CSCL 21E

Lean combustion limits were determined for a premixed prevaporized propane air mixture with flat plate flame stabilizers. Experiments were conducted in a constant area flame tube combustor utilizing flameholders of varying percentages of blockage and downstream counterbores. Combustor inlet air velocity at ambient conditions was varied from 4 to 9 meters per second. Flameholders with a center hole and four half holes surrounding it were tested with 63, 73, and 85 percent blockage and counterbore diameters of 112 and 125 percent of the thru hole diameter, in addition to the no counterbore configuration. Improved stability was obtained by using counterbore flameholders and higher percentages of blockage. Increases in mixture velocity caused the equivalence ratio at blowout to increase in all cases. Author

**N83-34942\*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.  
**STUDY OF LH2-FUELED TOPPING CYCLE ENGINE FOR AIRCRAFT PROPULSION**  
G. E. TURNEY and L. H. FISHBACH 1983 21 p refs Presented at the Aircraft Design Systems and Operations Meeting, Fort Worth, Tex., 17-19 Oct. 1983; sponsored by AIAA and AHS  
(NASA-TM-83466; E-1735; NAS 1.15:83466) Avail: NTIS HC A02/MF A01 CSCL 21E

An analytical investigation was made of a topping cycle aircraft engine system which uses a cryogenic fuel. This system consists of a main turboshaft engine which is mechanically coupled (by cross-shafting) to a topping loop which augments the shaft power output of the system. The thermodynamic performance of the topping cycle engine was analyzed and compared with that of a reference (conventional-type) turboshaft engine. For the cycle operating conditions selected, the performance of the topping cycle engine in terms of brake specific fuel consumption (bsfc) was determined to be about 12 percent better than that of the reference turboshaft engine. Engine weights were estimated for both the topping cycle engine and the reference turboshaft engine. These estimates were based on a common shaft power output for each engine. Results indicate that the weight of the topping cycle engine is comparable to that of the reference turboshaft engine. Author



**N83-34944\*#** General Electric Co., Lynn, Mass. Aircraft Engine Business Group.

**ROTORCRAFT CONVERTIBLE ENGINE STUDY Final Report**  
D. N. GOLDSTEIN, R. HIRSCHKRON, and C. E. SMITH Aug. 1983 211 p refs  
(Contract NAS3-22743)  
(NASA-CR-168241; NAS 1.26:168241; R83AEB047) Avail: NTIS HC A10/MF A01 CSCL 21E

Convertible propulsion systems for advanced rotorcraft are evaluated in terms of their impact on aircraft operating economics and fuel consumption. A variety of propulsion system concepts, including separate thrust and power producing engines, convertible fan/shaft engines, and auxiliary propeller configurations are presented. The merits of each are evaluated in two different rotorcraft missions: an intercity, commercial transport of the ABC(TM) type, and an offshore oil ring supply ship of the X-wing type. The variable inlet guide vane fan/shaft converting engine and auxiliary propeller configurations are shown to offer significant advantages over all the other systems evaluated, in terms of both direct operating cost and fuel consumption. S.L.

**N83-34945\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**EFFECTS OF WIND ON TURBOFAN ENGINES IN OUTDOOR STATIC TEST STANDS**

J. G. MCARDLE and A. S. MOORE 1983 15 p refs Presented at the 2nd Flight Testing Conf., Las Vegas, Nev., 16-18 Nov. 1983; sponsored by the AIAA, AHS, IES, SETP and SFTE (NASA-TM-83493; E-1824; NAS 1.15:83493) Avail: NTIS HC A02/MF A01 CSCL 21E

Wind can affect measured thrust and can cause turbofan engine speed to fluctuate during outdoor testing. Techniques used at an outdoor test stand at NASA Lewis Research Center to make testing easier and faster and to improve data repeatability include using an inflow control device (ICD) to make fan speed steadier, taking many raw data samples for better averaging, and correcting thrust for wind direction and speed. Data from engine tests are presented to show that the techniques improve repeatability of thrust and airflow measurements under various wind conditions. Author

**N83-34946\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**USE OF COOLING AIR HEAT EXCHANGERS AS REPLACEMENTS FOR HOT SECTION STRATEGIC MATERIALS**

J. W. GAUNTNER 19 Oct. 1983 11 p refs Presented at Aircraft Design Systems and Operations Meeting, 17-19 Oct. 1983; sponsored by AIAA and AHS (NASA-TM-83494; E-1827; NAS 1.15:83494) Avail: NTIS HC A02/MF A01 CSCL 21E

Because of financial and political constraints, strategic aerospace materials required for the hot section of future engines might be in short supply. As an alternative to these strategic materials, this study examines the use of a cooling air heat exchanger in combination with less advanced hot section materials. Cycle calculations are presented for future turbofan systems with overall pressure ratios to 65, bypass ratios near 13, and combustor exit temperatures to 3260 R. These calculations quantify the effect on TSFC of using a decreased materials technology in a turbofan system. The calculations show that the cooling air heat exchanger enables the feasibility of these engines. Author

**N83-34947\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**SUPERSONIC FAN ENGINES FOR MILITARY AIRCRAFT**

L. C. FRANCISCUS 19 Oct. 1983 12 p refs Presented at Aircraft Design Systems and Operations Meeting, Fort Worth, Tex., 17-19 Oct. 1983; sponsored by AIAA and AHS (NASA-TM-83499; E-1833; NAS 1.15:83499) Avail: NTIS HC A02/MF A01 CSCL 21E

Engine performance and mission studies were performed for turbofan engines with supersonic through-flow fans. A Mach 2.4 CTOL aircraft was used in the study. Two missions were considered:

a long range penetrator mission and a long range intercept mission. The supersonic fan engine is compared with an augmented mixed flow turbofan in terms of mission radius for a fixed takeoff gross weight of 75,000 lbm. The mission radius of aircraft powered by supersonic fan engines could be 15 percent longer than aircraft powered with conventional turbofan engines at moderate thrust to gross weight ratios. The climb and acceleration performance of the supersonic fan engines is better than that of the conventional turbofan engines. Author

**N83-34948\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**HIGH-PRESSURE FLAME VISUALIZATION OF AUTOIGNITION AND FLASHBACK PHENOMENA WITH LIQUID-FUEL SPRAY**

C. J. MAREK and C. E. BAKER 18 Oct. 1983 18 p refs Presented at Western States Sec. Fall Meeting, 17-18 Oct. 1983; sponsored by the Combustion Inst., Los Angeles (NASA-TM-83501; E-1840; NAS 1.15:83501) Avail: NTIS HC A02/MF A01 CSCL 21E

A study was undertaken to determine the effect of boundary layers on autoignition and flashback for premixed Jet-A fuel in a unique high-pressure windowed test facility. A plate was placed in the center of the fuel-air stream to establish a boundary layer. Four experimental configurations were tested: a 24.5-cm-long plate with either a pointed leading edge, a rounded edge or an edge with a 0.317-cm step, or the duct without the plate. Experiments at an equivalence ratio ranging from 0.4 to 0.9 were performed at pressures to 2500 kPa (25 atm.) at temperatures of 600, 645, and 700 K and velocities to 115 meters per second. Flame shapes were observed during flashback and autoignition using high speed cinematography. Flashback and autoignition limits were determined. Author

**N83-34949#** Massachusetts Inst. of Tech., Cambridge. Gas Turbine and Plasma Dynamics Lab.

**CURRENT PROBLEMS IN TURBOMACHINERY FLUID DYNAMICS Annual Report, 1 Oct. 1981 - 30 Nov. 1982**

E. M. GREITZER, W. T. THOMPSON, JR., J. E. MCCUNE, A. H. EPSTEIN, C. S. TAN, E. E. COVERT, W. R. HAWTHORNE, and F. H. DURGIN 30 Dec. 1982 135 p refs (Contract F49620-82-K-0002; AF PROJ. 2307) (AD-A126478; AFOSR-83-0147TR) Avail: NTIS HC A07/MF A01 CSCL 21E

Fan and compressor design points fluid dynamics are investigated including formation of design procedures using three dimensional transonic codes and development of advanced measurement techniques for use in transonic fans. Other studies include (1) basic mechanisms of compressor stability enhancement using compressor casing/hub treatment, (2) fluid mechanics of inlet vortex flow distortions in gas turbine engines, and (3) three dimensional flows in highly loaded turbomachines (including blade to blade flow analysis and numerical computations of secondary flow in a bend using spectral methods. GRA

**N83-34950#** Ohio State Univ., Columbus.

**HEAT TRANSFER ON THREE TURBINE AIRFOILS Final Report, 1 Jun. 1979 - 1 Jan. 1982**

L. S. HAN, A. CHAIT, W. F. BOYEE, and J. R. RAPP Jan. 1983 252 p refs (Contract F33615-79-C-2036; AF PROJ. 2066) (AD-A128762; AFWAL-TR-82-2124) Avail: NTIS HC A12/MF A01 CSCL 20D

An experimental heat transfer program and a smoke visualization study were conducted on three turbine airfoils in a stationary cascade tunnel. The three blades with different profile shapes were scaled to have a same chord length of 21 inches; all blade models had a turning angle of 72 degrees. The ranges of the test parameters were for the Reynolds number, from 7.8 x 10 to the 5th power to 1.5 x 10 to the 6th power; and for main stream turbulence intensity, from 0.8 to 8.0 percent. On a blade with severe pressure-side curvature where a previous investigation had revealed intermittent bursts of Gortler vortices, the measured heat transfer rates were 20 to 50 percent higher than those on

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the blade with least pressure-side curvature where the flow was mostly laminar. Evidence of the heat transfer distributions strongly indicates transition to turbulent boundary layers with Gortler vortices as a catalyst. Chordwise heat transfer fluctuations or waviness, which were also observed in other investigations, were found to exist in cases where Gortler vortices made their presence. In regions of strong streamwise acceleration, upstream turbulence intensity and Gortler vortices became less potent in raising the heat transfer rates. In the leading edge region, data from this study agreed well with the empirical correlations between the local curvature Reynolds number and the freestream turbulence intensity. GRA

**N83-34951#** Calspan Advanced Technology Center, Buffalo, N.Y. Aerodynamic Research Dept.

**ROTATING STALL INVESTIGATIONS. VOLUME 1: THEORETICAL INVESTIGATIONS Final Report, 15 Aug 1979 - 15 Oct 1982**

J. P. NENNI, G. F. HOMICZ, and G. R. LUDWIG Wright-Patterson AFB, Ohio AFWAL Jan. 1983 109 p refs 2 Vol. (Contract F33615-79-C-2023; AF PROJ. 3066) (AD-A128744; CALSPAN-6568-A-6-VOL-1; AFWAL-TR-83-2002-VOL-1) Avail: NTIS HC A06/MF A01 CSCL 13G

This report presents the results of a research program on rotating stall in axial flow compressors and jet engines. The program had three major objectives which were: (1) develop an analysis for a three dimensional, time-variant rotating stall and separation theory, (2) develop analysis for post-stall operation/recovery and aerodynamically induced exotic metal combustion, and (3) consider the effects of distortion, water ingestion, and nuclear blasts on axial flow compressors. The work done towards accomplishing objective (1) is reported in Volume 1. The work done towards the accomplishment of the remaining two objectives is reported in Volume 2. Volume 1 contains the description of an implicit time marching Euler code, a small disturbance stability theory for the compressible flow through a compressor stage, and a three dimensional unsteady lifting surface theory for annular blade rows. Author (GRA)

**N83-34952#** Calspan Advanced Technology Center, Buffalo, N.Y. Aerodynamic Research Dept.

**ROTATING STALL INVESTIGATIONS. VOLUME 2: EXPERIMENTAL STUDIES Final Report, 15 Aug. 1979 - 15 Oct. 1982**

G. R. LUDWIG and J. P. NENNI Wright-Patterson AFB, Ohio AFWAL Jan. 1983 312 p refs 2 Vol. (Contract F33615-79-C-2023; AF PROJ. 3066) (AD-A128745; CALSPAN-6568-A-6-VOL-2; AFWAL-TR-83-2002-VOL-2) Avail: NTIS HC A14/MF A01 CSCL 13G

This report presents the results of a research program on rotating stall in axial flow compressors and jet engines. The program had three major objectives which were: (1) develop an analysis for a three dimensional, time-variant rotating stall and separation theory, (2) develop analysis for poststall operation/recovery and aerodynamically induced exotic metal combustion, and (3) consider the effects of distortion, water ingestion, and nuclear blasts on axial flow compressors. The work done towards accomplishing objective (1) is reported in Volume 1. The work done towards the accomplishment of the remaining two objectives is reported in Volume 2 presented herein. The experimental studies were performed on a low-speed rotating annular cascade facility and on a J-85-5 turbojet engine. The low-speed tests investigated the influence of rotor-stator interference on the work performed by a rotor in a stage prior to and during rotating stall, both with and without inlet distortion. The J-85 experiments consisted of post-stall temperature measurements in the compressor and a demonstration of stall anticipation and stall recovery on this engine with a previously developed rotating stall control system in operation. In addition, some blast tests were performed on the J-85 with the stall control system both operative and inoperative. Comparisons are made between the low-speed experimental results and the

predictions of a previously developed two dimensional rotating stall stability theory. In addition, post-stall analyses were performed on both the low-speed results and the J-85 results for comparison with the predictions of Day, Greitzer, and Cumpsty.

Author (GRA)

**N83-34953#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

**PROPULSION AND ENERGETICS PANEL WORKING GROUP 14 ON SUITABLE AVERAGING TECHNIQUES IN NONUNIFORM INTERNAL FLOWS**

M. PIANKO, ed. (ONERA, Chatillon, France) and F. WAZELT, ed. (Technische Hochschule Darmstadt, West Germany) 1982 172 p (AGARD-AR-182(ENG.)) Avail: NTIS HC A08/MF A01

Numerous investigations were made into how the average properties across a nonuniform or unsteady flow to characterize it for the purpose of one dimensional performance of a gas turbine powerplant. Collection and review of existing practice or proposal for averaging nonuniform and or unsteady flows; identification of averaging techniques to calculate heat, power, thrust, and efficiency; qualification where applicable of uncertainty levels of different averaging methods, recommendation of methods for adoption, and recommendation of further research activities to resolve uncertainties were studied. Author

**N83-36029\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**APPARATUS FOR IMPROVING THE FUEL EFFICIENCY OF A GAS TURBINE ENGINE Patent**

G. A. COFFINBERRY, inventor (to NASA) (GE, Cincinnati) 20 Sep. 1983 7 p Filed 20 Mar. 1980 Supersedes N83-14130 (21 - 05, p 0622) Sponsored by NASA (NASA-CASE-LEW-13142-1; US-PATENT-4,404,793; US-PATENT-APPL-SN-132364; US-PATENT-CLASS-60-39.07) Avail: US Patent and Trademark Office CSCL 21E

An energy recovery system is provided for an aircraft gas turbine engine of the type in which some of the pneumatic energy developed by the engine is made available to support systems such as an environmental control system. In one such energy recovery system, some of the pneumatic energy made available to but not utilized by the support system is utilized to heat the engine fuel immediately prior to the consumption of the fuel by the engine. Some of the recovered energy may also be utilized to heat the fuel in the fuel tanks. Provision is made for multiengine applications wherein energy recovered from one engine may be utilized by another one of the engines or systems associated therewith.

Official Gazette of the U.S. Patent and Trademark Office

**N83-36031\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**MULTI-FUEL ROTARY ENGINE FOR GENERAL AVIATION AIRCRAFT**

C. JONES (Curtiss-Wright Corp.), D. R. ELLIS (Cessna Aircraft Co.), and P. R. MENG 27 Jun. 1983 86 p refs (NASA-TM-85428; NAS 1.15:85428) Avail: NTIS HC A05/MF A01 CSCL 21E

Design studies, conducted for NASA, of Advanced Multi-fuel General Aviation and Commuter Aircraft Rotary Stratified Charge Engines are summarized. Conceptual design studies of an advanced engine sized to provide 186/250 shaft KW/HP under cruise conditions at 7620/25,000 m/ft. altitude were performed. Relevant engine development background covering both prior and recent engine test results of the direct injected unthrottled rotary engine technology, including the capability to interchangeably operate on gasoline, diesel fuel, kerosene, or aviation jet fuel, are presented and related to growth predictions. Aircraft studies, using these resultant growth engines, define anticipated system effects of the performance and power density improvements for both single engine and twin engine airplanes. The calculated results indicate superior system performance and 30 to 35% fuel economy improvement for the Rotary-engine airplanes as compared to

equivalent airframe concept designs with current baseline engines. The research and technology activities required to attain the projected engine performance levels are also discussed. Author

**N83-36032#** Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.

**FLOW PROBLEMS IN TURBOMACHINES Annual Report, 1 Mar. 1982 - 28 Feb. 1983**

T. C. ADAMSON, JR. and A. F. MESSITER 15 Apr. 1983 43 p refs

(Contract N00014-79-C-0285; NR PROJ. 094-395; RR0240301) (AD-A128675; AR-1) Avail: NTIS HC A03/MF A01 CSCL 20D

A brief discussion is given of the work done on the three problems studied during the period covered by this report. The problems considered are: (1) transonic flow through heavily loaded cascades, (2) transonic flow through a three dimensional compressor rotor, and (3) supersonic flow with a turbulent boundary layer at a ramp. Author (GRA)

**N83-36033#** Solar Turbines International, San Diego, Calif. **MID AND HIGH TEMPERATURE ROTOR PROGRAM FOR A 30 KW GAS TURBINE GENERATOR SET Final Technical Report**

C. RODGERS and W. D. TREECE Dec. 1982 76 p refs (Contract DAAK70-80-C-0152)

(AD-A129780; MERADCOM-82472; ERR-0287) Avail: NTIS HC A05/MF A01 CSCL 21E

The objective of this program was the advancement of small radial inflow turbine technology in the area of operation at higher turbine inlet gas temperatures. A two-phase program was structured. In the first phase, two mid-temperature range 4.50-inch tip diameter radial inflow turbine rotors, were designed for a 30-kW gas turbine with a maximum turbine inlet nozzle temperature of 2200 F. One rotor was internally air-cooled and the other conduction-cooled in a monorotor (integral turbine and compressor) arrangement. On the basis of performance, structural and cost analyses, the monorotor arrangement was selected for continued development evaluation. A ceramic high temperature rotor was also studied for operation at a maximum turbine inlet nozzle temperature of 2600 F. Estimated failure probability for this high temperature rotor study was too high to warrant continuation.

GRA

**N83-36034#** Detroit Diesel Allison, Indianapolis, Ind. **ADVANCED DIGITAL CONTROLLER DEVELOPMENT PROGRAM, TASK 1 Interim Report, 1 Sep. 1979 - 30 Sep. 1980**

J. H. HUNTER Wright-Patterson AFB, Ohio AFWAL Jul. 1982 76 p

(Contract F33657-79-C-0728; AF PROJ. 3066) (AD-A129269; AFWAL-TR-82-2047; DDA-EDR-10431) Avail: NTIS HC A05/MF A01 CSCL 21E

The objective of this program phase was to develop the specification for a digital controller. This controller would have sufficient computing and I/O capability to control a variable cycle (VCE) single spool (e.g., GMA 200 ATEGG) or two spool (e.g., GMA200 JTDE) configuration. Provision has been made for seven controlled variables. These are: two fuel flows, variable compressor and turbine geometry, two cooling bleed flows, and variable nozzle area. A multivariate control logic structure was selected. Power commands, mode, and ambient conditions are used to estimate the equilibrium operating point. These schedules will then be adjusted to match the engine characteristics using an adaptive control algorithm. Optimal paths between operating points will be computed by a trajectory generator module. A proportional regulator is designed to track small perturbation from this nominal path. The design concept for a digital controller capable of implementing this control logic was developed. This required a specification of the GMA200 fuel control system with particular emphasis on the controller interface. Trade studies were identified and their impact on the control hardware presented. These included actuator selection, fuel system selection, and airflow measurement techniques. Timing and sizing studies were completed. This resulted

in the selection of a bit-slice processor (an Am 2901) with 28K EPROM/RAM. GRA

**N83-36035#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

**NUMERICAL MODELLING OF RAMJET COMBUSTORS Final Report, Oct. 1981 - Aug. 1982**

W. H. HARCH Feb. 1983 66 p refs (Contract AF PROJ. 2308)

(AD-A129631; AFWAL-TR-82-2113) Avail: NTIS HC A04/MF A01 CSCL 21E

The present work deals with development of computer codes for modelling of gas turbine combustors to ramjet combustor configurations. In particular, the STARPIC code of Lilley and Rhode has been expanded to include reacting compressible flows.

Author (GRA)

**N83-36036#** Sundstrand Aviation-Rockford, Ill. **IMPROVEMENTS IN F-16 ENGINE RESTART CAPABILITY WITH A SIPU (SUPER INTEGRATED POWER UNIT) Final Report, Dec. 1981 - Oct. 1982**

W. G. SMITH and R. J. FANDEL Wright-Patterson AFB, Ohio AFWAL Dec. 1982 42 p

(Contract F33615-82-M-2220; AF PROJ. 3145) (AD-A129578; AFWAL-TR-82-2118) Avail: NTIS HC A03/MF A01 CSCL 01C

The F-16 main engine inflight restart capability would be greatly enhanced by utilizing a Super Integrated Power Unit (SIPU). Because the available starter power remains constant at all altitudes, the engine can be motored at relatively high rotative speeds, providing for rapid acceleration to a self sustaining condition after refight. This reduced start time plus a multiple start capability, reduces altitude loss and increases safety during combat. The SIPU concept expands the airstart window and allows the pilot to assume a best range flight attitude which increases both time and range by up to 35% in the event the engine is not able to start. Author (GRA)

**N83-36399#** Mitsubishi Heavy-Industries Ltd., Nagoya (Japan). Engine Dept.

**DEVELOPMENT OF HIGH LOADING, HIGH EFFICIENCY AXIAL FLOW TURBINE**

K. TAKESHIMA, Y. TONOMURA, T. SATOO (Takasago Inst.), H. NOUSE (National Aerospace Lab., Tokyo), M. MINODA (National Aerospace Lab., Tokyo), and K. TAKAHARA (National Aerospace Lab., Tokyo) /In Japan Society for Aeronautical and Space Sciences Trans. of the Japan Soc. for Aeron. and Space Sci., Vol. 25, No. 68 p 91-103 Aug. 1983 refs Original language document was announced as A82-47069

Avail: NTIS HC A04/MF A01

Results of an experimental investigation of a high loading, high efficiency, axial flow turbine are presented. A numerical model is developed for the streamline along the stages using the Euler equation of radial motion. A tailored spanwise static pressure distribution is found to be available by control and combination of the vortex and meridional velocity distribution. An analytical method was employed to minimize the rate of diffusion on the airfoil blade surface. M.S.K. (IAA)

## AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A83-47201#

ELECTROMECHANICAL CONTROL SYSTEMS  
[ELEKTROMECHANISCHE STELLSYSTEME]

H. MOLL (Teldix GmbH, Heidelberg, West Germany) and S. KRAUS (Zahnradfabrik Friedrichshafen AG, Friedrichshafen, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. Sponsorship: Bundesministerium fuer Forschung und Technologie. (Contract BMFT-LFL-8280)

The design of a modular system of electromechanical actuators for aircraft flaps and steering surfaces is reported. The prototype development program is restricted to a spoiler system for taxiing, braking, and ground-spoiler functions on a wing similar to that of the A-310 Airbus. The design concept uses a brushless, mechanically commutated 270-V dc motor under electronic control. The choice and design of the motor are discussed in detail. The drive system is based on a Wolfrom gear unit, preceded by two rotating and one stationary planetary gear units. The material, lubrication, corrosion prevention, and testing of the drive train are summarized. Preliminary tests of the entire system are found to confirm the correctness of the design approach. Block diagrams, graphs of test results, and drawings of system components are provided. T.K.

A83-47212#

OLGA - A GUST-ALLEVATION SYSTEM FOR  
GENERAL-AVIATION AIRCRAFT [OLGA - EIN  
BOEENABMINDERUNGSSYSTEM FUER FLUGZEUGE DER  
ALLGEMEINEN LUFTFAHRT]

H. BOEHRET (Dornier GmbH, Friedrichshafen, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 15 p. In German.

The design and testing of an Open-Loop Gust-Alleviation system (OLGA) for small aircraft are reported. OLGA is intended to decrease passenger airsickness by compensating for gusts in the frequency range around 0.3 Hz. The prototype OLGA is built for a Do-28 aircraft equipped with an advanced-technology wing; compensation is achieved via symmetrically electromechanically activated ailerons and elevators. A closed-loop controller is incorporated in the OLGA for fine adjustment. Wind-tunnel, computer-simulation, ground, and some flight tests have been completed successfully. Block diagrams and photographs of OLGA and the prototype installation are shown. T.K.

A83-47213#

COMMERCIAL AIRCRAFT WITH REDUCED LONGITUDINAL  
STABILITY AND ACTIVE TAIL PLANES, AND THE UNSTEADY  
AERODYNAMICS OF RAPIDLY ADJUSTED CONTROL  
SURFACES [UNTERSUCHUNGEN ZU VERKEHRSFLUGZEUGEN  
MIT REDUZIERTER LAENGSSSTABILITAET UND AKTIVEM  
LEITWERK SOWIE ZUR INSTATIONAEREN AERODYNAMIK  
SCHNELL BEWEGTER STEUERFLAECHE]

H. G. KKLUG (Messerschmitt-Boelkow-Blom GmbH, Hamburg, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 43 p. In German. refs

Aerodynamic studies and design concepts for a more efficient commercial aircraft (based on the Airbus A-310) are summarized. One approach considered involves shifting the center of gravity toward the tail during flight by means of a computer-controlled trim-tank system, possibly coupled with an active, smaller 'flying

tail'. It is shown that with the center of gravity near but still in front of the maneuvering point the aircraft is still manually flyable in an emergency, and an overall operating-cost saving of 2-3 percent can be obtained. The second approach seeks to reduce gust and maneuvering loads on outer wing surfaces by rapid active compensation by closed-loop-controlled ailerons or spoilers. Wind-tunnel experiments confirm the feasibility of the technique and supply input data for ongoing optimization studies. T.K.

A83-48345#

A NEW APPROACH TO FAULT-TOLERANT HELICOPTER  
SWASHPLATE CONTROL

B. K. WALKER (MIT, Cambridge, MA), E. GAI, and M. N. DESAI (Charles Stark Draper Laboratory, Inc., Cambridge, MA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 13 p. refs

(AIAA PAPER 83-2485)

A new method for controlling the orientation of a helicopter swashplate is developed from basic principles and evaluated by simulation. The method applies to rise-and-fall swashplates which are controlled by redundant actuators for the purpose of achieving survivability and fault-tolerance. The suggested control scheme maintains all of the actuators in an active stage, thereby avoiding transient effects following component failures and also making possible the use of simple but effective comparison-type failure diagnostics. In addition, the scheme alleviates the 'force-fighting' which is prevalent in redundant actuation designs via a minimum norm concept which conserves hydraulic energy. A simulation of the swashplate dynamics is then developed and used to evaluate the performance of the new controller design relative to that of other suggested multiactuator swashplate controller designs in terms of dynamic response, alleviation of force fights, and detection of actuator failures. Author

A83-48371#

OPTIMAL CONTROLLER DESIGN FOR A HELICOPTER USING  
ITS LOWER ORDER DYNAMIC MODEL

B. L. NAGABHUSHAN (Goodyear Aerospace Corp., Akron, OH) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 7 p. Research supported by the Virginia Polytechnic Institute and State University. refs

(AIAA PAPER 83-2550)

An optimal controller is designed for a helicopter by considering its lower order dynamic model. The corresponding control law has been obtained by constructing the steady state solution to the matrix Riccati equation for such a dynamic system along with its adjoint system. The resulting feedback gains are subsequently modified and applied to more complex models of the aircraft which include effects of rotor blade dynamics and external influences, such as, a sling load. Robustness of this design is illustrated here by examining closed loop control of a typical helicopter operating alone or with a sling load. Author

A83-49191

ACTIVE CONTROL OF NEAR FREQUENCY COALESCENCE  
FLUTTER

M. R. TURNER (British Aerospace PLC, Aircraft Group, Weybridge, Surrey, England) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 308-318.

A description is provided of an analytical study of an example of explosive flutter in which it is not possible to obtain active flutter control with good stability margins by using a single input, single output feedback with a simple control law. In the considered case, an active flutter control model of the YF-17 was tested in a 16-foot transonic dynamics wind tunnel. The YF-17 model characteristics are discussed, taking into account flutter curves and open loop transfer functions. The theory of frequency coalescence flutter is considered along with the frequency response of frequency coalescence flutter, the control laws for active flutter

control of frequency coalescence flutter, effective changes to the flutter equations, and the application of a control law. G.R.

**A83-49193**

**ACTIVE GUST LOAD ALLEVIATION AND RIDE COMFORT IMPROVEMENT**

J. BECKER, O. SENSBURG, and F. WEISS (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 349-375. refs

A description is presented of programs which have been conducted by a West German aerospace company with the objective to develop gust load control and ride improvement systems. The layout of gust load control concepts for the Airbus A300 is discussed. Maximum alleviations of symmetrical gust loads are obtained through activated outboard ailerons, spoilers, and elevators. The modeling of the elastic aircraft is considered, taking into account the description of the analytical model, the loads, a quasi-steady model, and an unsteady analytical model. The design of a ride improvement system for a modern fighter aircraft configuration is also examined, giving attention to an open loop ride improvement system and a closed loop ride improvement system. G.R.

**A83-49594#**

**APPLICATION OF OPTIMAL CONTROL SYNTHESIS TO INTEGRATED VERTICAL FLIGHT PATH AND AIRSPEED CONTROL FOR AN ADVANCED FIGHTER**

L. L. MUNGER, C. M. CARLIN (Boeing Military Aircraft Co., Seattle, WA), and D. GANGSAAS (Boeing Commercial Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 9 p. (AIAA PAPER 83-2560)

Linear quadratic synthesis is applied to the design of an integrated vertical flight path and airspeed command and stability augmentation control law for the AFTI/F-111 aircraft. A feedforward controller combined with full-state feedback provides nearly decoupled response to normal and longitudinal acceleration commands, as well as steady-state tracking of vertical flight path and airspeed. Integral control of the flap commands maintains the wing camber for minimum drag in steady-state maneuvers. Enhanced maneuverability and reduction of pilot workload are achieved through coordinated commands to the leading and trailing edge flaps, stabilons and engines. The control law demonstrates significant reduction of normal acceleration responses to turbulence as compared to the unaugmented aircraft. Final design evaluation was performed on a nonlinear six-degree-of-freedom real time piloted simulation. The fixed gain design performed well over a wide range of flight conditions, from landing approach to supersonic high altitude cruise. Author

**A83-50074\*#** Boeing Military Airplane Development, Seattle, Wash.

**INTEGRATED CONTROL SYSTEM CONCEPT FOR HIGH-SPEED AIRCRAFT**

C. M. CARLIN and J. D. BLAIR (Boeing Military Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 9 p. refs (Contract NAS1-16942) (AIAA PAPER 83-2564)

The synthesis and evaluation of flight control system architectures for future aircraft are discussed in terms of design features and the requirements for fighter aircraft. Advanced fighter configurations may feature canards, flaperons, two-dimensional vectoring nozzles, a mixing compression inlet, and an advanced turbojet engine. Survey and evaluation technology will also progress to include distributed microprocessors, VLSI and VHSIC microcircuitry, optical circuits, analytic redundancy, etc. Bottom-up and top-down architectures have been investigated to fulfill the reliability, maintainability, cost, and performance goals. A

centralized architecture has been devised with line-removable units to facilitate maintainability and reduce weight. Descriptions are provided of the performance parameters and applications of optical elements, photoelastic pressure sensors, rare earth sensors, computing elements, and information transfer system. M.S.K.

**N83-34900\*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.

**ANALYTIC REDUNDANCE MANAGEMENT FOR FLIGHT CONTROL SENSORS**

J. C. DECKERT (Draper (Charles Stark) Lab.) and K. J. SZALAI IN AGARD Advan. in Sensors and their Integration into Aircraft Guidance and Control Systems 13 p Jun. 1983 refs Avail: NTIS HC A08/MF A01 CSCL 01C

The formulation and flight test results of an algorithm to detect and isolate the first failure of any one of 12 duplex control sensor signals (24 in all) being monitored are reviewed. The technique uses like signal differences for fault detection while relying upon analytic redundancy relationships among unlike quantities to isolate the faulty sensor. The fault isolation logic utilizes the modified sequential probability ratio test, which explicitly accommodates the inevitable, irreducible low frequency errors present in the analytic redundancy residuals. In addition, the algorithm used sensor output selftest, which takes advantage of the duplex sensor structure by immediately removing a hard failed sensor from control calculations and analytic redundancy relationships while awaiting a definitive fault isolation decision via analytic redundancy. This study represents a proof of concept demonstration of a methodology that is applied to duplex or higher flight control sensor configurations and, in addition, can monitor the health of one simplex signal per analytic redundancy relationship. Author

**N83-34954** Illinois Univ., Urbana.

**ANGLE-OF-ATTACK FEEDBACK IN MANUAL AIRCRAFT CONTROL: PILOTING TECHNIQUES AND SOME FLIGHT TRAINING IMPLICATIONS Ph.D. Thesis**

N. M. KARAYANAKIS 1983 249 p Avail: Univ. Microfilms Order No. DA8302904

The applied aspects of the angle of attack control loop in the manual control of fixed wing aircraft are examined. With respect to the role of angle of attack information in manual control, the pertinent control loop elements are examined; these include the pilot, the aircraft and the angle of attack system. Attention is focused on the rate of change of angle of attack and its significance in dynamic aircraft control. Existing fixed wing piloting techniques are compared. The term piloting technique is defined and analyzed operationally. Emphasis is placed on the development of angle of attack piloting techniques. Specific practical piloting techniques are presented which employ the Karayanakis model, a catholic approach for use in fixed wing aircraft. A dual element angle of attack display is proposed as part of a displacement and rate dual loop model in which rate of change of angle of attack is a separate entity. Implications of its use to prevent accidents at takeoff are discussed. Dissert Abstr.

**N83-34955#** Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.

**NEW FLIGHT CONTROL TECHNOLOGIES FOR FUTURE NAVAL AIRCRAFT Interim Report**

W. W. KANIUKA Sep. 1982 200 p refs (AD-A128624; NADC-82240-60) Avail: NTIS HC A09/MF A01 CSCL 01C

This report describes new flight control technologies that were developed in part or fully under Navy R&D funding for future advanced aircraft. The main thrust of these developmental programs was in the areas of digital flight control systems, advanced control surface actuators, and integrated sensory subsystems. Author (GRA)

**N83-36037#** Air Force Academy, Colo.  
**OPTIMAL PERIODIC CONTROL Final Report, Oct. 1980 - Dec. 1982**  
 R. T. EVANS May 1983 30 p refs  
 (Contract AF PROJ. 2305)  
 (AD-A130114; FJSRL-TR-83-0005) Avail: NTIS HC A03/MF A01 CSDL 01C

The stated objective of this research was to develop the theory and computational technique for optimizing the flight path of an aircraft with respect to fuel consumption (maximize range for a given amount of fuel) during the cruise segment of flight. It then was intended to apply these tools to a point mass model of an aircraft and determine a locally optimizing cyclic cruise flight path in a proof of principle demonstration. Their are numerous potential applications for this research. The more obvious Air Force benefits include: extend the range of an air vehicle with a fixed amount of fuel; reduce its fuel requirements for a given range hereby increasing its load capability; and increase its endurance allowing it to remain aloft longer. The improvements of periodic cruise flight paths appear to be most suited for remotely piloted aircraft or cruise missile type applications. However, in many emergency or back-up operations, it also would be quite feasible for manned systems. GRA

## 09

### RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

**A83-47197#**  
**STUDIES CONCERNING MODEL TECHNOLOGY IN THE EUROPEAN TRANSONIC WIND TUNNEL (ETW) [STUDIEN ZUR MODELL-TECHNOLOGIE IM ETW]**  
 P. ESCH (Dornier GmbH, Friedrichshafen, West Germany) and R. LEISTNER (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 42 p. In German. refs

Attention is given to a model design study which has the objective to determine the feasibility of a simulation of the aerodynamic aircraft properties in the transonic velocity range under the cryogenic flow conditions of the ETW. The study is concerned with general configuration considerations for current and future aircraft, and parameter and material studies. In addition, the practicality of simulation studies in the ETW is investigated for the military aircraft Tornado. A project description is provided, and test conditions in the ETW are discussed along with the model scale, the accuracy requirements, the characteristics of the employed models, recommendations for material selection, special materials for flutter models, a cryogenic test chamber, the model mechanisms, and predesign work related to the Tornado model. G.R.

**A83-47207#**  
**STATUS REPORT ON THE EUROPEAN TRANSONIC WIND TUNNEL AND ON THE COLOGNE CRYOTUNNEL [STATUSBERICHT ZUM EUROPÄISCHEN TRANSSCHALL WINDKANAL UND ZUM KRYO-KANAL-KOELN]**

F. MAURER and G. VIEHWEGER Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 48 p. In German. refs

Planned revisions of the design of the European transonic wind tunnel are reported, emphasizing the planned enlargement of the tunnel and the financing of needed alterations. The revisions include the cancellation of an expensive pressure lock and possible

alternatives involving compartmentalization of the measurement chamber. The possibility of supplementary internal insulation to deal with fatigue problems caused by fast variations in temperature is considered. The energy requirements of various phases of the project, the building costs, and the planned mean discharge plan are discussed. C.D.

**A83-47208#**  
**DEVELOPMENT OF A SIX-COMPONENT WEIGHING DEVICE FOR CRYOGENIC APPLICATIONS [ENTWICKLUNG EINER 6-KOMPONENTEN-WAAGE FÜR DEN KRYO-BEREICH]**  
 B. EWALD (Darmstadt, Technische Hochschule, Darmstadt, West Germany) and E. GRAEWE (Vereinigte Flugtechnische Werke GmbH, Bremen, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 33 p. In German. refs

The design and manufacture of an unheated 6-component rod scale for the model mounting shaft of a cryogenic wind tunnel are discussed. The application requires a compact device capable of bearing heavy loads and remaining accurate at temperatures from 90 to 320 K. The device constructed used electron-beam welded maraging steel for the body, type-WK wire strain gauges, and epoxy-resin glue and coating material. Materials testing at different temperatures and temperature gradients is summarized, drawings and photographs of the device are shown, and the design of the calibration shell is described. The errors in the measurement of axial forces which arose due to temperature gradients are corrected by means of software which takes the measured temperature distribution in the device into account, thus accounting for even nonlinear effects. T.K.

**A83-47209#**  
**DESIGN, CONSTRUCTION, AND OPERATION OF THE CALIBRATION MODEL FOR THE DNW WIND TUNNEL [KONSTRUKTION, BAU UND EINSATZ DES DNW-EICHMODELLS]**  
 H. P. FRANZ and K. KASZEMEIK (Vereinigte Flugtechnische Werke GmbH, Bremen, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 42 p. In German. refs

A calibration model for the Deutsche-Niederlaendische Windkanal, based on the configuration of the Airbus A-300 passenger aircraft, is presented. The scale 1:9.5 was chosen to allow measurements in all geometric positions in the normal 8 x 6-m airflow and in cruising positions in the fast 6 x 6-m airflow of the DNW wind tunnel, as well as in the S1 and F1 ONERA wind tunnels. The construction techniques, instrumentation, and testing of the model are discussed, and experiments performed and planned are listed. Photographs, drawings, and graphs of sample results are provided. T.K.

**A83-47226#**  
**THE TECHNOLOGY OF ADAPATIVE WIND-TUNNEL WALLS [DIE TECHNIK ADAPTIVER WINDKANALWÄENDE]**  
 U. GANZER (Berlin, Technische Universität, Berlin, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 22 p. In German. refs

The theory of adaptive-wall 3D wind tunnels and examples of the design and operation of both variable-porosity and flexible-wall wind tunnels are discussed. The problems involved in extrapolating wind-tunnel test measurements with tunnel-wall interference effects to real flight situations are outlined, and the principles of wall adaptation are introduced. The chief advantage of the variable-porosity method, as illustrated by the AEDC tunnel design, is seen in its use of available theoretical knowledge, practical experience, and tunnel geometry. The design and control electronics of the flexible-wall transsonic tunnel built at the Technische Universität Berlin are presented in detail, and some test results are summarized and illustrated. T.K.



A83-48135#

**HYPersonic DYNAMIC TESTING OF ABLATING MODELS WITH THREE-DEGREE-OF-FREEDOM GAS BEARINGS**

F. J. REGAN and M. V. KRUMINS (U. S. Navy, Naval Surface Weapons Center, Silver Spring, MD) *Journal of Spacecraft and Rockets* (ISSN 0022-4560), vol. 20, Sept.-Oct. 1983, p. 470-476. refs

Previously cited in issue 19, p. 2971, Accession no. A82-39131

**A83-48212\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.**  
**EVALUATION OF FOUR SUBCRITICAL RESPONSE METHODS FOR ON-LINE PREDICTION OF FLUTTER ONSET IN WIND TUNNEL TESTS**

C. L. RUHLIN, J. J. WATSON, R. H. RICKETTS, and R. V. DOGGETT, JR. (NASA, Langley Research Center, Loads and Aeroelasticity Div., Hampton, VA) (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers. Part 2, p. 94-101) *Journal of Aircraft* (ISSN 0021-8669), vol. 20, Oct. 1983, p. 835-840. refs

Previously cited in issue 13, p. 2024, Accession no. A82-30140

A83-48217#

**MODEL TEST AND FULL-SCALE CHECKOUT OF DRY-COOLED JET RUNUP SOUND SUPPRESSORS**

J. L. GRUNNET (Fluidyne Engineering Corp., Minneapolis, MN) and E. FERENC (U.S. Navy, Naval Facilities Engineering Command, Alexandria, VA) *Journal of Aircraft* (ISSN 0021-8669), vol. 20, Oct. 1983, p. 866-871.

Previously cited in issue 17, p. 2696, Accession no. A82-35079

A83-48349#

**HIGH TEMPERATURE/PRESSURE TESTING OF HEAT RESISTANT RUNWAY MATERIALS**

H. FLUK (U.S. Naval Air Engineering Center, Lakehurst, NJ) and G. Y. WU (U.S. Navy, Naval Civil Engineering Laboratory, Port Hueneme, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 11 p. refs  
 (AIAA PAPER 83-2492)

It has been found that state-of-the-art pavement surfacings are adversely affected by engine exhaust while operating in the V/STOL mode. An investigation was conducted with the objective to identify materials which are suited for applications involving an environment of high performance V/STOL aircraft. The investigation has been conducted in three phases. In the first, theoretical studies predicted temperature distributions under typical VTOL heating conditions. In the second phase, various materials were subjected to the exhaust of an afterburning J79-8 engine. The third phase is to be conducted in October 1983. It will include additional tests of materials found to be successful during phase two. Attention is given to the approach used in the investigation, aspects of materials selection, panel fabrication, test facilities, acceptance criteria for test materials, and test results. G.R.

A83-49181

**SURVEY OF AEROELASTIC WIND TUNNEL AND FLIGHT TESTING METHODS AT MBB**

H. HOENLINGER and M. STEININGER (Messerschmitt-Boelkow-Blom GmbH, Munich, West Germany) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 93-104. refs

Although analytical prediction methods regarding the aeroelastic behavior of an aircraft have been improved during the last few years, it is still necessary and cost effective to use various types of wind tunnel models in the investigations. Aeroelastic wind tunnel test methods are discussed, taking into account geometrically scaled models, and the measurement of oscillatory aerodynamic

forces with wind tunnel models. Dynamically scaled wind tunnel model tests are also considered, giving attention to subsonic flutter models, high speed flutter models, and the use of dynamically scaled models for investigating active control techniques. Questions of parameter identification are explored, and the progress made in digital analysis techniques is examined. G.R.

A83-49182

**PRACTICAL APPLICATIONS OF SYSTEM IDENTIFICATION IN FLUTTER TESTING**

C. W. SKINGLE (Royal Aircraft Establishment, Farnborough, Hants., England) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 121-129.

A method of deriving the equations of motion of an aeroelastic system from measured response data is presented. The structural and aerodynamic terms are separately identified by analyzing response measurements at two values of dynamic pressure; the derived equations can then be used to predict the dynamic characteristics of the system and, in particular, its stability at other values of dynamic pressure. Results are presented from two different wind tunnel flutter model tests to show the practical application of this technique to the prediction of flutter characteristics. An extension of the technique to provide data for the design of flutter suppression systems is also described.

Author

A83-49184

**SURVEY OF THE STATE OF THE ART IN MODERN GROUND VIBRATION TESTING**

N. NIEDBAL (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Aeroelastik, Goettingen, West Germany) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 143-150. refs

Substantial advances were made in the recent past with respect to the ground vibration test techniques for aircraft. A very significant advantage of the new methods is related to the fact that appropriated exciter forces in the sense of the classical phase resonance method are unnecessary. Attention is given to the basic dynamic equations, the classical phase resonance method, the phase separation methods, and possibilities regarding a further development of the ground vibration test technique. It is found that a further development of the experimental modal analysis technique may be possible by making use of a combination of the phase resonance method with the characteristics of the phase separation methods. G.R.

A83-49426#

**IMPROVEMENT OF A CAPTIVE TRAJECTORY SYSTEM BY USING OPTICAL DISTANCE SENSORS**

B. SELLIER and L. MARTIN (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (International Congress on Instrumentation in Aerospace Simulation Facilities, 10th, Saint-Louis, Haut-Rhin, France, Sept. 20-22, 1983) ONERA, TP, no. 1983-115, 1983, 7 p.  
 (ONERA, TP NO. 1983-115)

The captive trajectory system installed in the Modane 5S2MA wind tunnel provides the capability to determine the separation trajectory of a store as it moves from a parent aircraft. Several types of sensors have been considered in order to measure directly the initial distance between the aircraft model and the missile. Optical sensors were finally chosen. The main difficulty in using them is their sensitivity to wind tunnel lighting; this problem has been solved with an electronic signal processing method. Transversal translation of a cylindrical missile is also measured by using two sensors. Author

## 09 RESEARCH AND SUPPORT FACILITIES (AIR)

**N83-34957#** Air Force Engineering and Services Center, Tyndall AFB, Fla.  
**PROGRAM MANAGEMENT PLAN (PMP) FOR RAPID RUNWAY REPAIR (RRR)**

15 Apr. 1983 69 p refs

(AD-A128565) Avail: NTIS HC A04/MF A01 CSCL 05A

The objective of the Rapid Runway Repair (RRR) Program is to provide the US Air Force the capability to recover from conventional weapons attacks on USAF runways and airfields, thereby permitting expeditious launch and recovery of operational aircraft. The RRR Program conceives, develops, tests, and validates: methods, materials, and equipment to rapidly repair airfield pavements following an enemy attack; and designs of alternate launch and recovery surfaces. This program is not expected to produce a single, unique solution, but rather several validated concepts and solutions which can be used in combination to significantly improve USAF readiness posture. The scope of this program is limited to developments, testing, and fielding of civil engineering techniques to repair paved surfaces, to improve unpaved surfaces, and to create required support allow aircraft operations from the surfaces in spite of threat attacks. Modification to aircraft will not be attempted even though such modifications may turn out to be more effective than extensive engineering of airfield surfaces. Class 2 aircraft modification will only be accomplished to support instrumentation sensing devices. GRA

**N83-34959#** Georgia Univ., Athens. Inst. of Government.  
**SMALL AIRPORT MANAGEMENT HANDBOOK**

Jun. 1982 146 p refs

(Contract NSF ISP-79-08955)

(PB83-194043; NSF/ISP-82038) Avail: NTIS HC A07/MF A01 CSCL 01E

Results are presented of a survey undertaken to examine the management needs of small airports. A majority of the respondents reported potential legal problems. To questions pertaining to managerial practices at the airports, a majority of the respondents reported problems associated with safety procedures, as well as problems in adopting revenue charges comparable to those at other airports. A majority of the respondents reported problems associated with petroleum services, and indicated the need for written fire regulations and written emergency weather procedures. Fundamentals of small airport management are noted, as are some of the legal problems that an airport manager may face. Recommendations for airport management practices are supplied. GRA

**N83-36039\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**EXPANDED OPERATIONAL CAPABILITIES OF THE LANGLEY MACH 7 SCRAMJET TEST FACILITY**

S. R. THOMAS and R. W. GUY Oct. 1983 74 p refs

(NASA-TP-2186; L-15565; NAS 1.60:2186) Avail: NTIS HC A04/MF A01 CSCL 14B

An experimental research program conducted to expand the operational capabilities of the NASA Langley Mach 7 Scramjet Test Facility is described. Previous scramjet testing in this facility was limited to a single simulated flight condition of Mach 6.9 at an altitude of 115 300 ft. The arc heater research demonstrates the potential of the facility for scramjet testing at simulated flight conditions from Mach 4 (at altitudes from 77,000 to 114,000 ft) to Mach 7 (at latitudes from 108,000 to 149,000 ft). Arc heater electrical characteristics, operational problems, measurements of nitrogen oxide contaminants, and total-temperature profiles are discussed. Author

**N83-36040#** BDM Corp., McLean, Va.

**THE EFFECTS OF WEATHER ON RAPID RUNWAY REPAIR, VOLUME 1 Final Report, 30 Jun. - 5 Nov. 1982**

J. M. WHITEHEAD, M. D. HOFFMAN, P. G. POTTER, C. P. NEUSWANGER, and M. M. WILDING Tyndall AFB, Fla. Air Force Engineering and Services Center. May 1983 215 p refs 2 Vol.

(Contract F08635-80-C-0206; AF PROJ. 2621)

(AD-A130409; BDM/W-82-592-TR-VOL-1;

AFESC/ESL-TR-82-41-VOL-1) Avail: NTIS HC A10/MF A01 CSCL 01E

This technical report is divided into two volumes. Volume 1 contains the technical analysis and weather effects on RRR process, while Appendix A, Weather Data, is published as Volume 2 because of its size. This report presents the results of a study to identify the effects of weather on Rapid Runway Repair (RRR). There are two major components of the study. The first characterizes the aspects of weather that affect RRR, by area for Korea, Europe, and England. Graphs present data on temperature, precipitation, visibility, wind, and humidity. The second component studies the effects of weather on the RRR process. The process is divided into activities, with associated efficiencies under various weather conditions. Values for the efficiencies are developed from military and industrial data. The two components are combined with a critical path analysis of several RRR procedures. The report identifies potential solutions to some weather-related problems, and make recommendations for further study. GRA

**N83-36041\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**A PILOTTED SIMULATOR INVESTIGATION OF SIDE-STICK CONTROLLER/STABILITY AND CONTROL AUGMENTATION SYSTEM REQUIREMENTS FOR HELICOPTER VISUAL FLIGHT TASKS**

K. H. LANDIS, P. J. DUNFORD, E. W. AIKEN, and K. B. HILBERT May 1983 16 p refs Presented at the 39th Ann. Forum of the Am. Helicopter Soc., St. Louis, May 1983 Prepared in cooperation with Boeing Vertol Co., Philadelphia (Contract NAS2-10880)

(NASA-CR-172852; NAS 1.26:172852; AD-A129833) Avail: NTIS HC A02/MF A01 CSCL 01C

A piloted simulator experiment was conducted to assess the effects of side-stick controller characteristics and level of stability and control augmentation on handling qualities for several low-altitude control tasks. Visual flight tasks were simulated using four-window computer-generated imagery depicting either a nap-of-the-Earth course or a runway with obstacles positioned to provide a slalom course. Both low speed and forward flight control laws were implemented, and a method for automatically switching control modes was developed. Variations in force-deflection characteristics and the number of axes controlled through an integrated side-stick were investigated. With high levels of stability and control augmentation, a four-axis controller with small-deflection in all four axes achieved satisfactory handling qualities for low-speed tasks. GRA

**N83-36042#** Lea (N. D.) and Associates, Inc., Washington, D.C.  
**ASSESSMENT OF HOUSTON AIRPORT WEDWAY AUTOMATED TRANSIT SYSTEM Final Report**

D. MUOTOH, D. DUNOYE, H. MOORE, and W. SCOTT Apr. 1983 202 p refs Prepared in cooperation with Elliott (Dennis) and Associates, Inc., Arlington, Tex.

(Contract DTUM60-81-C-71089)

(PB83-210443; UMTA-IT-06-0248-83-2) Avail: NTIS HC A10/MF A01 CSCL 01E

This report presents the results of an assessment of the WEDway Automated Transit System installed at the Houston Intercontinental Airport in Houston, Texas. Included in this assessment report are a system description, a technical subsystems review and evaluation, an assessment of system performance and cost, and implementation history. During the assessment, the system was measured on the requirements for urban transit application. Information and data presented were

collected through a comprehensive process involving literature surveys, interviews with airport and manufacturer's personnel, review of operating and maintenance logs, and a site visit.

Author (GRA)

## 10

## ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

## A83-47330#

## THE REACTION MOTORS DIVISION - THIOKOL CHEMICAL CORPORATION

F. I. ORDWAY (Alabama Space and Rocket Center, Huntsville, AL) and F. H. WINTER (National Air and Space Museum, Washington, DC) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 6 p. refs

(IAF PAPER 83-289)

A description is presented of the administrative history of the considered division, taking into account developments until June 1972 when the division came to a formal end. The various projects undertaken by this organization are discussed, giving attention to prepackaged engines for Navy air-launched missiles, the X-15 research aircraft, vernier units for Surveyor spacecraft, and other vernier developments. It is pointed out that the division was at a disadvantage with competitors in the western states who were free to test their rockets in areas remote from heavily populated centers.

G.R.

## A83-47333#

## LIQUID PROPELLANT ROCKET DEVELOPMENT BY THE U.S. NAVY DURING WORLD WAR II

R. C. TRUAX (Truax Engineering, Inc., Saratoga, CA) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 6 p.

(IAF PAPER 83-298)

Work related to the development of liquid propellant rockets by the U.S. Navy was initiated in May of 1941. It was first planned to employ rockets as an aid for the takeoff of large seaplanes. The design of a full size rocket motor was started in late spring of 1942, while takeoff tests were conducted in the spring of 1943. Attention is given to engines using nitric acid-aniline propellants, a gas generator built in 1943, the Gorgon IIA air-to-air missile, a surface-to-air missile, the engine used on the first supersonic aircraft, and plans for using a small, fast, radio-controlled aircraft to carry an explosive charge which would destroy enemy bombers.

G.R.

## A83-47338#

## ORBIT PREDICTION FOR IRAS USING VECTOR AND ANALYTIC TECHNIQUES

R. HOLDAWAY (Science and Engineering Research Council, Rutherford Appleton Laboratory, Didcot, Oxon, England) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 11 p. refs

(IAF PAPER 83-315)

This paper describes the techniques of a vector approach to the solution of the differential equations of motion of a near-earth satellite. The method provides a good stable foundation for developing the orbital elements, thus allowing an analytic approach to be used in subsidiary algorithms. The mathematical concepts used in these algorithms are explained, and equations are developed for calculating earth and moon eclipses, radiation zone

crossings, atmospheric density effects, solar cell decay, look angles and a geographical ephemeris. Results are presented for the IRAS satellite, and show that prediction errors of less than 1 1/2 seconds over one week or errors of less than 15 seconds over 3 1/2 months are possible.

Author

## A83-48248

## COMPLEX OPTIMIZATION OF ENGINE SYSTEMS FOR SPACECRAFT CONTROL [KOMPLEKSNAIA OPTIMIZATSIIA DVIGATEL'NYKH USTANOVOK SISTEM UPRAVLENIIA]

V. V. KOKORIN, N. B. RUTOVSKII, and E. V. SOLOVEV Moscow, Izdatel'stvo Mashinostroenie, 1983, 184 p. In Russian. refs

The present work develops a methodology for the complex optimization of low-thrust engine systems for the attitude control and stabilization of spacecraft. Particular emphasis in the complex optimization is placed on the mutual influence of engine-system dynamics, engine elements, and vehicle elements; and on the interrelation between engine-system performance indices and parameters determining the character of system operation. A complex of algorithms for different levels of the hierarchical structure of the design of an optimal engine system is elaborated.

B.J.

## 11

## CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

## A83-47937#

## THE EFFECT OF HYDROCARBON STRUCTURE UPON FUEL SOOTING TENDENCY IN A TURBULENT SPRAY DIFFUSION FLAME

T. T. BOWDEN and J. H. PEARSON (Shell Research, Ltd., Thornton Research Centre, Chester, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 6 p. Research supported by the Ministry of Defence. refs

(ASME PAPER 83-GT-90)

The sooting tendencies of various hydrocarbon structures have been studied in a model gas turbine combustor at a pressure of 0.35 MPa and a preheated air temperature of 530 K. The results of this study have indicated that the sooting tendencies of fuels containing only single ring aromatics, fused bicyclic saturates, and unsaturated nonaromatics will be related to the overall hydrogen content of the fuel. However, experimental fuel blends with high concentrations (greater than 20 percent wt) of naphthalenes or tetralins exhibit sooting properties that are dependent upon the presence of such components. It is suggested that a kinetic scheme utilizing aromatic rings as nuclei upon which reactive fragments may stabilize can explain the present results.

Author

## A83-47942#

## USE OF PYROLYSIS-DERIVED FUEL IN A GAS TURBINE ENGINE

J. M. KASPER, G. B. JASAS, and R. L. TRAUTH (Teledyne CAE, Toledo, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. refs

(Contract DE-AC03-78ET-13333)

(ASME PAPER 83-GT-96)

A J69-T-29 gas turbine combustor rig has been used to demonstrate the combustion characteristics of a pyrolytically derived fuel whose feedstocks were agricultural and forest products and wastes and whose constituents are an oil and a residual char. The char was ground to a mean size of 25 microns and mixed with both the pyrolysis oil and JP-4 in additional combustor rig tests. Analysis of the oil and char showed them to have

hydrogen/carbon ratios of less than 1.0. The J69 combustion system consists of an annular combustor and a centrifugal fuel injector rotating at shaft speed which can use slurry fuels without clogging. It also provides good atomization of viscous fuels. Test results indicate that the use of pyrolytic oil will result in engine combustion efficiencies of over 99 percent. O.C.

**A83-48027#****DROP SIZE MEASUREMENTS IN EVAPORATING REALISTIC SPRAYS OF EMULSIFIED AND NEAT FUELS**

L. G. DODGE and C. A. MOSES (Southwest Research Institute, San Antonio, TX) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 10 p. refs (Contract N0014-80-K-0460) (ASME PAPER 83-GT-231)

Results are presented for a comparative study of the drop-size distribution of sprays of emulsified and neat distillate-type aviation fuels at elevated temperatures (308-700 K) and pressures (101-586 kPa). It is shown that there are substantial differences in the evaporation characteristics of emulsified fuels when compared with neat fuels. The spray droplets of the evaporating emulsified fuel are found to be, on the average, significantly smaller than the droplets of neat fuel at corresponding elevated temperature/pressure conditions. These differences are determined to increase as the pressure rises in the range examined. These results are found to be consistent with the microexplosion hypothesis, although alternative explanations cannot be ruled out. The experimental data indicate that the size of drops at initial atomization depends strongly on the air pressure. N.B.

**A83-48034#****DEVELOPMENT OF THE SINGLE CRYSTAL ALLOYS CM SX-2 AND CM SX-3 FOR ADVANCED TECHNOLOGY TURBINE ENGINES**

K. HARRIS, G. L. ERICKSON, and R. E. SCHWER (Cannon-Muskegon Corp., Muskegon, MI) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 11 p. refs (ASME PAPER 83-GT-244)

Two complementary single-crystal alloys have been developed from MAR-M-247, a vacuum-melted nickel-base cast superalloy, with the objective of providing high strength, excellent oxidation resistance, good castability, practical solution heat-treatment ranges, and stable microstructures. The alloys, designated CM SX-2 and CM SX-3, are intended primarily for critical cast turbine blade and vane airfoil applications for military engines. Detailed stress-rupture, creep-rupture, tensile and cyclic mechanical properties, stability, and environmental properties are reported for 16 heats of CM SX-2 and 14 heats of CM SX-3. V.L.

**A83-48189#****ALUMINIDE COATINGS ON SUPERALLOYS**

C. DURET, R. MEVREL, and R. PICOIR (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, Advanced Study Institute on Surface Engineering, Les Arcs, Var, France, July 3-15, 1983) ONERA, TP, no. 1983-68, 1983, 18 p. refs (ONERA, TP NO. 1983-68)

The methods used to deposit aluminide coatings on nickel and cobalt superalloys currently used in advanced gas turbines are briefly discussed, as are the high-temperature properties of the coatings. Particular attention is given to low- and high-activity pack cementation processes. The effect of the composition and structure of aluminide and modified aluminide coatings on the hot corrosion and oxidation resistance of the coating-substrate system is illustrated by examples of coated nickel- and cobalt-base alloys, including single crystals and directionally solidified eutectics. Some of the superalloys discussed are IN 100, IN 738 LC, IN 939, X 40, X 45, MAR-M 509, COTAC 744, and CMSX2. V.L.

**A83-48286****BRAZING OF SILICON NITRIDE**

J. E. SIEBELS (Volkswagenwerk AG, Wolfsburg, West Germany) IN: Progress in nitrogen ceramics; Proceedings of the Second Advanced Study Institute, Brighton, England, July 27-August 7, 1981. Boston, MA and The Hague, Martinus Nijhoff Publishers, 1983, p. 455-463; Discussion, p. 463, 464.

Brazing techniques for joining silicon nitride components are discussed, with emphasis placed on the assembly of turbine rotors. The effect of process variables on the quality of brazed joints is examined, and experimental results for brazing of hot-pressed silicon nitride reaction-bonded silicon nitride with a Ti-Cu-Be alloy are presented. The use of brazing for connecting metallic and ceramic components is also shown to be possible. It is noted that thermal instability of silicon nitride materials, in particular reaction-bonded silicon nitride, is a critical factor in high-temperature brazing. Hence, further progress in the use of brazing will largely depend on the improvement of silicon nitride properties. V.L.

**A83-48308****US NATIONAL PROGRAMS IN CERAMICS FOR ENERGY CONVERSION**

R. N. KATZ (U.S. Army, Army Materials and Mechanics Research Center, Watertown, MA) and R. B. SCHULZ (U.S. Department of Energy, Washington, DC) IN: Progress in nitrogen ceramics; Proceedings of the Second Advanced Study Institute, Brighton, England, July 27-August 7, 1981. Boston, MA and the Hague, Martinus Nijhoff Publishers, 1983, p. 727-735. refs

The present investigation is primarily concerned with the utilization of ceramics for advanced heat engine developments. The driving force behind efforts to use ceramics in energy conversion devices is related to the need to lessen the dependence on imported oil and imported strategic metals. The full implementation of ceramic configured gas turbines and industrial heat exchangers could save \$17.5 billion in oil imports. The U.S. ceramic configured gas turbine programs during the time from 1971 to 1980 are discussed along with the U.S. ceramic configured heat engine programs for the time starting in the spring of 1981. Attention is given to a number of recent advances related to gas turbines, Diesel engine technology, and turbochargers. G.R.

**A83-48309****STATUS REPORT 1981 ON THE GERMAN BMFT-SPONSORED PROGRAMME 'CERAMIC COMPONENTS FOR VEHICULAR GAS TURBINES'**

W. BUNK (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne, West Germany) and M. BOEHMER IN: Progress in nitrogen ceramics; Proceedings of the Second Advanced Study Institute, Brighton, England, July 27-August 7, 1981. Boston, MA and The Hague, Martinus Nijhoff Publishers, 1983, p. 737-751.

The current status of a program initiated in 1974 with the aim of developing ceramic materials for vehicular gas turbines is reviewed, with attention given to both material and component development. The material systems discussed include reaction-bonded hot-pressed sintered, and hot-isostatic pressed silicon nitrides, silicon carbide with free silicon, and pressureless sintered, hot-pressed, and hot-isostatic pressed silicon carbide. The discussion also covers design concepts and test results for a hybrid rotor made of hot-pressed and reaction-bonded silicon nitride, a monolithic axial wheel of reaction-bonded silicon nitride, a monolithic rotor of hot-pressed silicon nitride, a radial wheel of Si-SiC, and a recuperative heat exchanger. The future development goals are examined. V.L.

**A83-48310****NITROGEN CERAMICS IN FRANCE**

M. BILLY, J. DESMAISON, and P. GOURSAT (Limoges, Université, Limoges, France) IN: Progress in nitrogen ceramics; Proceedings of the Second Advanced Study Institute, Brighton, England, July 27-August 7, 1981. Boston, MA and The Hague, Martinus Nijhoff Publishers, 1983, p. 753, 754.

Attention in France has been directed to the properties of ceramic materials based on either silicon carbide or silicon nitride and related systems. Nearly all the research programs on the development of silicon-based ceramics for structural applications at high temperatures have been funded by the state. Only two industrial companies have shown interest. One is able to produce several ceramic components for gas turbines; the other has concentrated its efforts on producing refractories for metallurgical applications (carbonitrides, 'nitride bonded-silicon carbide', or sialons, obtained by the carbothermal reduction of clays). The users of these products are involved with research in new energy conversion devices. However, the trend, especially in aerospace, is to place more emphasis on the development of composite materials rather than monolithic ceramics. Most of the basic research on nitrogen ceramics is done in public research centers in close cooperation with industrial research centers that are generally taking charge of the applied aspects. C.R.

**A83-48544****MONITORING THE CONTAMINATION OF JET FUELS BY CORROSION INHIBITORS [KONTROL' ZA POPADANIEM INGBITOROV KORROZII V REAKTIVNOE TOPLIVO]**

A. I. BELOUSOV and E. M. BUSHNEVA (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Neftianoi Promyshlennosti, Moscow, USSR) Khimiia i Tekhnologiiia Topliv i Masel (ISSN 0023-1169), Aug. 1983, p. 14, 15. In Russian. refs

The use of corrosion inhibitors of the IKB series in petroleum-distilling plants makes it possible to considerably reduce the corrosion of ferrous and nonferrous metals in the condensation-cooling system. However, the use of inhibitors in the fractionating column may lead to the contamination of the distilled fuel is monitored by measuring the electrical conductivity of the fuel. The method is shown to provide a reliable way to control the contamination of jet fuels by corrosion inhibitors. V.L.

**A83-48598****AN AIRLINE VIEW OF LH2 AS A FUEL FOR COMMERCIAL AIRCRAFT**

K. G. WILKINSON International Journal of Hydrogen Energy (ISSN 0360-3199), vol. 8, no. 10, 1983, p. 793-796.

An investigation is conducted concerning the prospects for the use of liquid hydrogen as fuel for commercial air transport. It is concluded that important benefits might be attained by designing commercial transport aircraft which use liquid hydrogen fuel. However, there is an awareness of difficulties and problems which have to be solved. The airlines need, therefore, an incentive before any drive for the required investment would be generated. Fears about the availability of more conventional fuel might provide such an incentive. At present, it appears to be assured that conventional fuel will be available for transport purposes until well into the next century. It is proposed that a modest program of carefully aimed research should be undertaken on an international basis to fill the most important gaps with respect to the needed technology and a knowledge of the economical aspects. G.R.

**A83-48636****THE USE OF CERAMICS FOR ENGINES**

D. J. GODFREY (Admiralty Marine Technology Establishment, Poole, Dorset, England) Materials and Design (ISSN 0261-3069), vol. 4, June-July 1983, p. 759-765. refs

The use of ceramics for engines is strongly influenced by their special properties and their brittle fracture behaviour. The engineering aspects of the available materials are discussed. The use of ceramics in gas turbines, internal combustion engines and tribological applications is reviewed, and complex engineering

behaviour and ceramic properties aspects requiring elucidation and research are discussed. Author

**A83-49481****EROSION-CORROSION OF COATINGS AND SUPERALLOYS IN HIGH VELOCITY HOT GASES**

C. T. KANG, S. L. CHANG, N. BIRKS, and F. S. PETTIT (Pittsburgh, University, Pittsburgh, PA) (Japan Institute of Metals, International Symposium on High Temperature Corrosion of Metals and Alloys, 3rd, Mount Fuji, Japan, Nov. 17-20, 1982) Japan Institute of Metals, Transactions, Supplement (ISSN 0021-4434), vol. 24, 1983, p. 87-101. refs

(Contract DAAG29-81-K-0027)

The combined erosion and corrosion of superalloys and coatings at ambient temperatures and high temperatures by hot gases is investigated. It is determined that combined erosion-corrosion of alloys may occur by different mechanisms. When the particle energy is very large, it is shown that erosion can predominate to the extent that evidence of the corrosion process is extremely difficult to detect on the surfaces of the alloys. However, it is found that, when the particle energy is low, the effects of the erosion process can be neglected compared to the corrosion process. In addition, the interaction of these two processes can take place for some particle energies and corrosion rates. Various types of interaction between the erosion and corrosion processes are examined. N.B.

**A83-49482****ALLOY DESIGN FOR HOT CORROSION RESISTANCE**

G. R. WALLWORK and J. M. NEWBURN (New South Wales, University, Sydney, Australia) (Japan Institute of Metals, International Symposium on High Temperature Corrosion of Metals and Alloys, 3rd, Mount Fuji, Japan, Nov. 17-20, 1982) Japan Institute of Metals, Transactions, Supplement (ISSN 0021-4434), vol. 24, 1983, p. 103-114. refs

The long term reactions between relevant inorganic compounds and various steels currently employed in high temperature environments are investigated, with the goal of designing systems to minimize or eliminate the hot corrosion problem. Some of the variables in the problem of hot corrosion are separated, and it is shown that the complex reactions in the fuel result in liquid compound reactions with the alloy. It is noted that the alloys generally employed to resist these reactions consist of nickel, cobalt, and iron alloyed with chromium and aluminum at levels sufficient to produce protective oxide layers. Results of oxidation studies indicate that alloys and coatings which, on oxidation, produce alumina scales, offer greater potential than existing alloys. It is shown that, in the area of power generation, when steels predominate for economical reasons, iron-aluminum alloys offer advantages over stainless steels. N.B.

**A83-49501****A FUNDAMENTAL BASIS FOR USING THE PLATINUM GROUP ELEMENTS AS ALLOYING ADDITIONS IN NICKEL-BASE ALLOYS TO IMPROVE HIGH TEMPERATURE CORROSION**

C. W. CORTI, D. R. COUPLAND, I. R. MCGILL, and C. W. HALL (Johnson Matthey, Metals Ltd., Research Centre, Reading, Berks., England) (Japan Institute of Metals, International Symposium on High Temperature Corrosion of Metals and Alloys, 3rd, Mount Fuji, Japan, Nov. 17-20, 1982) Japan Institute of Metals, Transactions, Supplement (ISSN 0021-4434), vol. 24, 1983, p. 351-361. refs

The effects are investigated of the addition of the platinum group elements on the structure and environmental properties of the austenitic solid solution gamma matrix and the L1 sub 2 ordered gamma-prime phase (Ni<sub>3</sub>Al), which constitute the foundation of most high strength nickel-base superalloys. The use of one or more of the platinum group elements as alloying constituents is found to give a further degree of flexibility in alloy design. Results are presented of engine simulation tests carried out on a platinum-containing alloy designed for industrial and marine gas turbine application, as well as a selection of commercial alloys, under severe hot corrosion conditions at temperatures of 740 and 900 C over a period of 800 hours. Also examined are the technical

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and economic viability of the platinum group metal approach to superalloy chemistry in terms of the ability to tailor alloys with specific combinations of mechanical and environmental properties to meet, cost effectively, increasingly severe performance targets for a wide range of industrial applications. N.B.

**A83-49583#**

### **MATERIAL SELECTION FOR THE NEW-TECHNOLOGY COMMERCIAL TRANSPORT - THE DESIGNER'S DILEMMA**

M. H. CALDWELL (Douglas Aircraft Co., Long Beach, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 6 p.

(AIAA PAPER 83-2477)

Materials which are candidates for incorporation in the structures of new-technology, 150 passenger commercial aircraft are discussed. Attention is given to aluminum alloy ingot and powder metallurgy, aluminum lithium alloy, aluminum matrix composites, carbon epoxy composites, and titanium. It is demonstrated how each material may be substituted for previous materials in particular applications to attain an overall weight savings with no loss of performance. Total weight savings of 5900 lb are calculated for a jet aircraft with two engines and an empty weight of 86,400 lb, implying an annual saving of almost \$67,000. Further advances in materials will increase the available savings in new aircraft designs. M.S.K.

**A83-49763**

### **A THEORETICAL STUDY OF THE NONSTATIONARY COMBUSTION OF A GASIFIABLE SOLID FUEL DURING A PRESSURE DROP [TEORETICHESKOE ISSLEDOVANIE NESTATSIONARNOGO GORENIIA GAZIFITSIRUIUSHCHEGOSIA TVERDOGO TOPLIVA PRI SPADE DAVLENIIA]**

B. V. LIDSKII, B. V. NOVOZHILOV, and A. G. POPOV (Vsesoiuznyi Simpozium po Goreniiu i Vzryvu, 7th, Chernogolovka, USSR, Oct. 1983) Fizika Gorenii i Vzryva (ISSN 0430-6228), vol. 19, July-Aug. 1983, p. 20-24. In Russian. refs

An abrupt pressure drop in the combustion chamber of a reaction engine can result in extinction. This effect is investigated here on the basis of a phenomenological theory using the type N fuel as an example. Experimental data are used to obtain interpolation expressions relating the combustion rate and the surface temperature to the pressure and initial temperature. A numerical method is proposed for solving an integral equation equivalent to the equation of heat conduction, and the position of the extinction curve is determined. The results obtained are compared with experimental data. V.L.

**A83-49769**

### **THE FORMATION OF CARBON MONOXIDE DURING TURBULENT DIFFUSION COMBUSTION [OBRAZOVANIE OKISI UGLERODA PRI TURBULENTNOM DIFFUZIONNOM GORENII]**

V. R. KUZNETSOV (Vsesoiuznyi Simpozium po Goreniiu i Vzryvu, 7th, Chernogolovka, USSR, Oct. 1983) Fizika Gorenii i Vzryva (ISSN 0430-6228), vol. 19, July-Aug. 1983, p. 42-45. In Russian. refs

In order to gain a better understanding of the mechanism of the formation of carbon monoxide in the combustion chambers of aircraft gas turbine engines, an analysis is made of combustion thermodynamics and of the effect of turbulence on the chemical reactions involved. It is shown that the flow of carbon monoxide depends on the scalar dissipation, while being essentially independent of the Reynolds number. It is noted that this conclusion does not contradict the self-similarity of turbulent flows with respect to the Reynolds number. V.L.

**A83-49778**

### **CHARACTERISTICS OF THE SUPERSONIC COMBUSTION OF NONMIXED GASES IN DUCTS [OSOBENNOSTI SVERKHZVUKOVOGO GORENIIA NEPEREMESHANNYKH GAZOV V KANALAKH]**

V. L. ZIMONT, V. M. LEVIN, E. A. MESHCHERIAKOV, and V. A. SABELNIKOV (Vsesoiuznyi Simpozium po Goreniiu i Vzryvu, 7th, Chernogolovka, USSR, Oct. 1983) Fizika Gorenii i Vzryva (ISSN 0430-6228), vol. 19, July-Aug. 1983, p. 75-78. In Russian. refs

The supersonic combustion of nonmixed gases in ducts is determined by turbulent exchange, chemical kinetics, and gas-dynamic effects accompanying heat release. Under certain conditions, each of the above factors can become critical. Experimental and analytical data are presented here which help to gain a better understanding of the role of these factors in the formation of flows. Particular attention is given to the effects of the deceleration of the supersonic flow to subsonic velocities, concentration fluctuations, and finite chemical reaction rates. V.L.

**N83-35162#** Ashland Petroleum Co., Ky.

### **REFINING OF MILITARY JET FUELS FROM SHALE OIL. VOLUME 3, PART 2: ABOVE GROUND SHALE OIL PROCESS DATA Interim Report, 15 Jun. - 30 Oct. 1980**

H. F. MOORE, L. M. HENTON, C. A. JOHNSON, and D. A. FABRY Mar. 1982 225 p refs

(Contract F33615-78-C-2080; AF PROJ. 2480; AF PROJ. 3048) (AD-A128635; AFWAL-TR-81-2056-VOL-3-PT-2) Avail: NTIS HC A10/MF A01 CSCL 21D

The effect of operating conditions on materials quality, energy balances, product composition and economics was evaluated and scale-p data were obtained and are tabulated for those unit operations of the Phase I process requiring laboratory data to confirm preliminary estimates. GRA

**N83-35163#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.

### **SUBLETHAL EFFECTS OF JP-4 ON LEPOMIS MACROCHIRUS Annual Report, 1 Nov. 1981 - 31 Oct. 1982**

J. CAIRNS, JR., A. L. BUIKEMA, JR., and T. R. DOANE Jan. 1983 11 p

(Contract AF-AFOSR-0059-82; AF PROJ. 2312) (AD-A128618; AFOSR-83-0443TR; AR-1) Avail: NTIS HC A02/MF A01 CSCL 06T

During the research project to investigate the sublethal effects of the water soluble fraction (WSF) of JP-4, a constant flow water soluble fractionator for the JP-4 was constructed. Procedures for chemical analyses to determine the percent of the WSF were developed and used. Static and dynamic bioassays were performed using the bluegill, *Lepomis macrochirus*. Blood chemistry tests were performed on control and exposed fish. Electron micrographs were taken of gill and liver tissue from control and exposed fish. Equipment and protocols were developed for measurement of respiration rates and preference/avoidance behavior of fish exposed to sublethal concentrations of the WSF of JP-4. GRA

**N83-35165#** Department of Energy, Bartlesville, Okla. Energy Technology Center.

### **AVIATION TURBINE FUELS, 1982**

F. M. SHELTON and C. I. DICKSON Mar. 1983 13 p (DE83-010848; DOE/BETC/PPS-83/2) Avail: NTIS HC A02/MF A01

Properties of some aviation turbine fuels marketed in the United States during 1982 are presented. The samples represented are typical 1982 production and were analyzed in the laboratories of 14 manufacturers of aviation turbine (jet) fuels. The data were submitted for study, calculation, and compilation under a cooperative agreement between the Department of Energy, Bartlesville Energy Technology Center, Bartlesville, Oklahoma, and the American Petroleum Institute. Results for the properties of 90 samples of aviation turbine fuels are included for military grades JP-4 and HP-5, and commercial type Jet A. DOE

**N83-36118\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**FIRE EXTINGUISHANT MATERIALS Patent**

R. L. ALTMAN (San Jose State Univ., Calif.), L. A. MAYER (San Jose State Univ., Calif.), and A. C. LING, inventors (to NASA) (San Jose State Univ., Calif.) 27 Sep. 1983 3 p Filed 3 Nov. 1981 Supersedes N82-12168 (20 - 03, p 0308) Sponsored by NASA

(NASA-CASE-ARC-11252-1; US-PATENT-4,406,797; US-PATENT-APPL-SN-317977; US-PATENT-CLASS-252-5; US-PATENT-CLASS-169-47; US-PATENT-CLASS-252-2) Avail: US Patent and Trademark Office CSCL 07D

Fire extinguishant composition comprising a mixture of a finely divided aluminum compound and alkali metal, stannous or plumbous halide is provided. Aluminum compound may be aluminum hydroxide, alumina or boehmite but preferably it is an alkali metal dawsonite. The metal halide may be an alkali metal, e.g. potassium iodide, bromide or chloride or stannous or plumbous iodide, bromide or chloride. Potassium iodide is preferred.

Official Gazette of the U.S. Patent and Trademark Office

**N83-36227#** McDonnell-Douglas Corp., Long Beach, Calif. Aircraft Div.

**ADHESIVE LAYER THICKNESS AND POROSITY CRITERIA FOR BONDED JOINTS Final Report, Aug. 1980 - Sep. 1982**

L. J. HART-SMITH Wright-Patterson AFB, Ohio AFWAL Dec. 1982 163 p refs

(Contract F33615-80-C-5092; AF PROJ. 2419) (AD-A129817; AFWAL-TR-82-4172) Avail: NTIS HC A08/MF A01 CSCL 13H

This investigation is concerned with two aspects of the effects of imperfections in adhesive bonds. These imperfections are nonuniform thickness and porosity (or, in the extreme case, flaws). Both cause redistribution of the load transfer with respect to that for nominally perfect bonds. A thorough treatment of induced peel stresses in structural joints and test coupons is included because the growth of bond flaws is known to be associated more with peel stresses than shear stresses in the adhesive. The report covers both the ductile adhesives most suitable for subsonic transport aircraft and the brittle adhesives needed for supersonic military aircraft. The first major section of the report discusses the effects of adhesive layer thickness variation, with particular emphasis on the ends of bonded overlaps where peak load transfer inevitably occurs. The second major topic is that of flaws and porosity; and it is shown that adhesive bonded joints are far more tolerant of such naturally occurring imperfections than is generally recognized. The final subject is that of peel stresses induced in the adhesive layer due to eccentricities in load path. While it is known that such peel stresses can be very detrimental to the life of bonded joints, it is shown here that it is often quite simple to eliminate them from structurally proportioned joints. GRA

**N83-36248#** Ashland Petroleum Co., Ky.

**REFINING OF MILITARY JET FUELS FROM SHALE OIL, PART 2, VOLUME 2 (IN SITU SHALE OIL PROCESS DATA) Interim Technical Report, Jun. 1979 - Oct. 1980**

H. R. MOORE, L. M. HENTON, C. A. JOHNSON, and D. A. FABRY Wright-Patterson AFB, Ohio AFWAL Mar. 1982 287 p 3 Vol.

(Contract F33615-78-C-2080; AF PROJ. 2480) (AD-A129031; AFWAL-TR-81-2056-VOL-2-PT-2) Avail: NTIS HC A13/MF A01 CSCL 21D

A complete EXTRACTACRACKING evaluation sequence has been performed for Occidental in situ shale oil. Extensive tests for hydrotreating, catalytic cracking, extraction and product upgrading were successfully performed. Data from these tests are contained in this volume. These tests demonstrate that this oil is an acceptable feedstock for EXTRACTACRACKING. Further, specification JP-4 and JP-8 turbine fuels were produced from these materials and provided to the Air Force. GRA

**N83-36249#** Ashland Petroleum Co., Ky.

**REFINING OF MILITARY JET FUELS FROM SHALE OIL. PART 3: PILOT PLANT SAMPLE PREPARATION Interim Report, Nov. 1979 - Jun. 1981**

F. H. TURRILL Wright-Patterson AFB, Ohio AFWAL Jul. 1982 101 p

(Contract F33615-78-C-2080; AF PROJ. 2480) (AD-A128722; AFWAL-TR-81-2056-PT-3) Avail: NTIS HC A06/MF A01 CSCL 21D

Phase 3 work performed was aimed at confirming final process design estimates proposed in Phase 1 and producing sample lots of turbine fuel for aircraft performance evaluations. Drum quantities of JP-4, JP-8 and Broadrange jet fuel were supplied to AFWAL, along with a gasoline blending component, diesel fuels, and residual fuels for these evaluations. Also, the scaled-up data from Phase 3 operating data were utilized in the Phase 4 Economic Evaluations. GRA

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## ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

**A83-47189#**

**APPLICATION OF ADVANCED CAD/CAM PROCEDURES IN AREAS OTHER THAN AIR TRANSPORT TECHNOLOGY [DIE ANWENDUNG VON WEITERENTWICKELTEN CAD/CAM-VERFAHREN AUF BEREICHE AUSSERHALB DER LUFTFAHRTTECHNIK]**

J. NAGEL (Dornier GmbH, Friedrichshafen, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 37 p. In German. refs

Current applications of CAD/CAM in various branches of industry other than aircraft technology, including production of gear wheels, ship drives, automobiles, machines, and electric parts are described. Problems of training personnel in the use of this technology are briefly considered. C.D.

**A83-47191#**

**THE INCREASE IN THE COST EFFECTIVENESS OF THE CONSTRUCTION OF AND PREPARATION OF MANUFACTURING PROCESSES FOR FLIGHT EQUIPMENT THROUGH INTEGRATED AND GRAPHIC DATA PROCESSING-CAD/CAM [ERHOEHUNG DER WIRTSCHAFTLICHKEIT DER KONSTRUKTION VON UND FERTIGUNGSVORBEREITUNG FUEER FLIEGENDES GERAET DURCH INTEGRIERTE UND GRAPHISCHE DATENVERARBEITUNG]**

R. FEDDERSEN (Messerschmitt-Boelkow-Blohm GmbH, Hamburg, West Germany) and U. GRUPE (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 24 p. In German.



A83-47203#

**USE OF FLIGHT ENGINE TECHNOLOGY IN STATIONARY INDUSTRIAL GAS TURBINES AND DIESEL MOTORS [NUTZUNG VON FLUGTRIEBWERKS-TECHNOLOGIE BEI STATIONÄREN INDUSTRIEGASTURBINEN UND DIESELMOTOREN]**

H. PRECHTER (Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) and B. BECKER (Kraftwerk Union AG, Muelheim, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 27 p. In German. refs

Significant cost savings can be attained by using flight engine technology in stationary gas turbines. Flight turbomotor component technology is being applied to advanced exhaust-driven superchargers. Radial compressors with high-efficiency backward-bending blades and large performance graph width permit increased loading pressure in modern diesel motors for ships and locomotives. Significant increases in efficiency for the same volume and small increases in production costs as well as improved fuel usage are attainable. The importance of efficient calculative methods as effective tools for solving complex problems is briefly discussed, as is the cooperation between the turbomachine industry and academic investigators. C.D.

A83-47206#

**THE CONSTRUCTION AND TESTING OF PILOT INSTALLATIONS FOR MAKING DIFFUSION CONNECTIONS AND FOR DEPOSITING LAYERS ON HIGH-ALLOY ENGINE COMPONENTS [AUFBAU UND ERPROBUNG VON PILOT-ANLAGEN ZUM DIFFUSIONSVERBINDEN UND BESCHICHTEN HOCHLEGIERTER TRIEBWERKSTEILE]**

P. ADAM (Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) Bundesministerium fuer Forschung und Technologie, Statusseminar ueber Luftfahrtforschung und Luftfahrttechnologie, 3rd, Hamburg, West Germany, May 2-4, 1983, Paper. 23 p. In German. refs

The present investigation is concerned with installations of recent origin which provide new constructive design possibilities and an approach for protecting the surface of turbine components exposed to high temperatures. The technique of making 'diffusion connections' involves the employment of only a very small amount of solder between the surfaces of the two components which are to be joined. Isothermal solidification occurs and remelting is impossible. The resulting structure is nearly without any disturbance and has a high strength. The considered technique is particularly suited for forged, powder-metallurgy, or cast highly heat-resistant alloys. It provides possibilities for the testing of the prototypes of novel blades and turbine wheels which consist at least of two components. A second type of installations discussed employs the technique of 'diffusion deposition' described by Adam (1980). Attention is also given to advances related to the technology of thermal spraying in a protective gas environment. G.R.

A83-47614

**AIRPLANE RELIABILITY IN A NUTSHELL**

K. PUNCHES (Hewlett-Packard Co., Corvallis, OR) IEEE Transactions on Reliability (ISSN 0018-9529), vol. R-32, June 1983, p. 130-133.

The terms and procedures employed in the area of commercial airplane reliability are examined. It is shown that this area of study requires a different approach to reliability because the topic of interest is the reliability of the schedule. Aspects examined include airplane readiness, down and repair times, and events which can cause schedule interruptions such as diversions or turnbacks. It is determined that excellent schedule reliability can be achieved even with an unreliable airplane system as long as the defects can be repaired before each flight without causing a delay. N.B.

A83-47808\* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**COHERENT CO<sub>2</sub> LIDAR SYSTEMS FOR REMOTE ATMOSPHERIC MEASUREMENTS**

J. W. BILBRO (NASA, Marshall Space Flight Center, Huntsville, AL) IN: Optical and laser remote sensing. Berlin, Springer-Verlag, 1983, p. 356-363.

Several examples of applications of coherent CO<sub>2</sub> Doppler lidar systems are summarized to illustrate the potential of these systems. The applications discussed include the use of continuous-wave systems for detecting and tracking aircraft wake vortices, transverse velocity measurements, and measurements of mass flow rates of high stack emissions. The use of pulsed coherent lidars is illustrated by applications involving the measurement of thunderstorm gust fronts, the measurement of wind profiles, and clear air turbulence detection. Following a summary of previous efforts, some current programs are reviewed. These include investigations into two-dimensional wind field measurements, atmospheric backscatter measurements, transverse velocity measurements, and the feasibility of space operations. V.L.

A83-47894#

**ALTERNATIVE VANELESS DIFFUSERS AND COLLECTING VOLUTES FOR TURBOCHARGER COMPRESSORS**

A. WHITFIELD and D. V. ROBERTS (Bath, University, Bath, Somerset, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. Research supported by the Holset Engineering Co. and Science Research Council. refs (ASME PAPER 83-GT-32)

Two vaneless diffuser/volute systems have been developed as alternatives to conventional practice, which employs the volute as a mere collector. The first of these designs transfers part of the diffusion process to a conical diffuser downstream of the volute, while the second allows diffusion to take place in the collecting volute itself. Experimental results are presented in the form of detailed pressure measurements in the diffuser system, as well as overall compressor characteristics, in order to compare the performance of the alternative designs. Prototype volute overall performance compares favorably with the standard design, despite the significant reduction of vaneless diffuser radius ratio and the use of full tongues in the new volutes. O.C.

A83-47927#

**EFFECT OF RELATIVE VELOCITY DISTRIBUTION ON EFFICIENCY AND EXIT FLOW OF CENTRIFUGAL IMPELLERS**

H. MISHINA and H. NISHIDA (Hitachi, Ltd., Mechanical Engineering Research Laboratory, Hitachi, Ibaraki, Japan) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. refs (ASME PAPER 83-GT-74)

A quasi-three-dimensional flow analysis proposed by Senoo and Nakase (1972) is applied in order to estimate the relative velocity distribution within a centrifugal impeller, assuming that the flow is both isentropic and inviscid. The relationship between relative velocity distribution, impeller efficiency, and meridional exit flow is experimentally investigated for the case of shrouded impellers having various relative velocity distributions. Analytical results are used to establish design criteria for the relative velocity distribution of centrifugal impellers. O.C.

A83-47935#

**COOLING AIRFLOW STUDIES AT THE LEADING EDGE OF A FILM-COOLED AIRFOIL**

E. S. TILLMAN (Bridgeport, University, Bridgeport, CT) and H. F. JEN (Avco Corp., Avco Lycoming Div., Stratford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 8 p. Research supported by the Avco Corp. refs (ASME PAPER 83-GT-82)

An experimental flow study on cooling holes in cylindrical models simulating the leading edge of a typical turbine airfoil is presented. The effect of external flow around the cylinder on the coolant

discharge through a single hole is represented as a function of the momentum ratio of the cooling jet to the local external flow. A similar correlation was found for the effect of internal axial flow. The ability to separate the entrance and exit effects on the hole is due to the fact that the hole is a long orifice. The entrance and exit effects on the coolant flow are expressed as loss coefficients analogous to traditional loss coefficients in pipe flow. The loss coefficients for single holes were used to predict the total and individual flows through an array of holes in the presence of an external flow field. The total flow is predicted accurately as compared to the results of tests on arrays of holes. It can be concluded that the interaction between adjacent cooling holes is slight. The physical model can be used for coolant optimization studies.

Author

#### A83-47968#

##### INERTIA EFFECTS OF THE DYNAMICS OF A DISK LEVITATED BY INCOMPRESSIBLE LAMINAR FLUID FLOW

D. K. WARINNER (Argonne National Laboratory, Argonne, IL) and J. T. PEARSON (Purdue University, West Lafayette, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 11 p. Research supported by the U.S. Department of Energy and NSF. refs

(ASME PAPER 83-GT-149)

This paper develops a nonlinear ordinary differential (O.D.E.) of motion for a disk parallel to a flat plate and levitated by incompressible laminar flow of fluid supplied from a central orifice. The fluid's inertia, reflected in high mass flow rate, is accounted for. The transient flow velocity and pressure field are found by iterative integration of the Navier-Stokes equation to determine the O.D.E. for the time-dependent height of the disk (or fluid film thickness). The film thickness is found by not only numerically integrating the O.D.E., but also by linearizing the equation to obtain a closed-form solution. The results of this combined squeeze-film, source-flow case compare favorably with experimental data presented which span cases from negligible inertia (viscous dominance) to cases of inertia dominance. Fortunately, the closed-form solution differs only slightly from the numerical solution; this provides relatively accurate expressions for the frequencies and damping coefficients in terms of the geometry, load (or weight of disk), mass flow rate, and the fluid properties.

Author

#### A83-47974#

##### EFFECTS OF ANOMALOUS ROTOR JOINTS ON TURBOMACHINE DYNAMICS

N. KLOMPAS (General Electric Co., Gas Turbine Div., Schenectady, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 11 p. refs

(ASME PAPER 83-GT-175)

Mechanisms simulating rotor joint restoring moments different from the common axisymmetric elastic hinge are derived and their effects on the dynamics of a complete turbomachine are calculated by impressing equivalent perturbing moments. A mechanism for locking subsynchronous whirl to a fractional frequency is described and supporting experimental observations are discussed. Sample analysis shows the possibility of self-sustained synchronous whirl due to preload asymmetry.

Author

#### A83-47975#

##### AN INVESTIGATION INTO THE EFFECT OF SIDE-PLATE CLEARANCE IN AN UNCENTRALIZED SQUEEZE-FILM DAMPER

R. A. COOKSON and L. J. DANTON (Cranfield Institute of Technology, Cranfield, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs

(ASME PAPER 83-GT-176)

An experimental investigation has been carried out into the influence of side-plate flow restrictors on the performance of a squeeze-film damper bearing. The experimental rig used was a flexible rotor with a disk positioned mid-way between two

squeeze-film damper bearings. One of the squeeze-film dampers was fitted with side-plates which could be adjusted and accurately located with respect to the squeeze-film damper journal. It has been found that the influence of the side-plate clearance on the ability of the squeeze-film damper to reduce the amplitude of the central disk can be considerable if the side-plate clearance is less than the radial clearance. As the side-plate clearance reduces towards zero, the effectiveness of the squeeze-film damper diminishes until the amplitudes obtained are the same as those measured when the rolling-contact bearing is rigidly supported. An interesting type of precessing elliptical orbit was discovered for conditions where the 'jump' phenomenon was operating.

Author

#### A83-47979#

##### FLUTTER OF MISTUNED TURBOMACHINERY ROTORS

O. O. BENDIKSEN (Princeton University, Princeton, NJ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. Research supported by Princeton University. refs

(ASME PAPER 83-GT-153)

An investigation of the fundamental aspects of flutter in mistuned turbomachinery rotors is presented. Perturbation methods are used to obtain asymptotic solutions to arbitrary order in the mistuning parameter. These solutions require only the knowledge of the eigensolution of the tuned system, and thus provide efficient formulas for calculating the effect of mistuning without solving a new eigenvalue problem. Numerical results presented for design parameters representative of fan rotors indicate that a critical reduced frequency exists, below which mistuning alone cannot stabilize the rotor. The sensitivity of the stability boundaries to mistuning was found to depend fundamentally on relations between the left and right eigenvectors. For systems where the left and right eigenvectors form complex conjugate pairs, mistuning cannot destabilize the system unless the reduced frequency of the least stable mode is decreased by the perturbation. In general, only cascades and rotors with a single degree-of-freedom per blade belong to this class.

Author

#### A83-47982#

##### VIBRATION ANALYSIS OF RADIAL COMPRESSOR IMPELLERS

J. WACHTER and H. CELIKBUDAK (Stuttgart, Universitaet, Stuttgart, West Germany) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs

(ASME PAPER 83-GT-156)

Such components of turbomachine dynamic behavior as natural frequency and mode shape are studied in the case of two centrifugal impeller types, through an FEM structural analysis, followed by natural frequency-determining experiments that are compared with the FEM results, and by an interferometric holography study of rotor dynamic behavior. FEM is found to be especially useful in the prediction of natural frequencies during a new rotor's design phase. If an existing rotor is to be considered for a new application, however, natural frequency testing is found to be the more economical of the approaches. The efficiency of interferometric holography for vibration mode observation is also noted.

O.C.

#### A83-47989#

##### IN SITU BALANCING OF FLEXIBLE ROTORS USING INFLUENCE COEFFICIENT BALANCING AND THE UNIFIED BALANCING APPROACH

M. S. DARLOW (Rensselaer Polytechnic Institute, Troy, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 5 p. refs

(ASME PAPER 83-GT-178)

In the case of current machinery designs, control of rotor vibration is a vital requirement to ensure machinery survival and operator safety. With respect to commercial aircraft, the safety of hundreds of passengers is the primary consideration. The most

common source of vibration in rotating machinery is mass unbalance. Rotor unbalance is removed with the aid of 'rotor balancing' procedures. The development of the microcomputer has made an in situ balancing of flexing rotors possible. The present investigation is concerned with an entirely self-contained, field-portable, full-featured, flexible rotor balancing system. The system features are related to automatic data acquisition, instruction-oriented user interaction, full influence coefficient capability, extensive data and influence coefficient enhancement capability, and hardcopy documentation of balancing procedure and results. Implementation of the Unified Balancing Approach (UBA) with this system is currently under development. G.R.

#### A83-47991#

##### A COMPARATIVE STUDY OF THE INFLUENCE OF DIFFERENT MEANS OF TURBINE COOLING ON GAS TURBINE PERFORMANCE

J. F. LOUIS, M. A. EL MASRI (MIT, Cambridge, MA), and K. HIRAKA. American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs  
(Contract E(49-18)-2295)  
(ASME PAPER 83-GT-180)

A comparative study is conducted of the influence of different means of turbine cooling on the thermodynamic efficiency and specific work of gas turbines. It is shown that the Brayton cycle efficiency and the specific power are sensitive to the type of cooling technique employed. Closed loop water cooling of both stationary and rotating components is found to provide a very good overall performance, especially when the blade temperature is low (800 K). The performance of steam cooled turbines, particularly film cooled, is found to be very favorable due to the high specific heat of steam and to the fact that the steam is generated using the waste heat from the turbine and expands through with the combustion gases. In addition, it is shown that the performance of turbines with air cooling is very sensitive to the difference between the turbine inlet and blade temperatures and also to the blade heat exchanger effectiveness. N.B.

#### A83-48006#

##### CERAMIC COMPONENTS FOR HIGH-TEMPERATURE VEHICULAR GAS TURBINES - STATE OF THE ART OF THE GERMAN CERAMIC PROGRAM

K. HAGEMEISTER (Muenchen, Technische Universitaet, Munich, West Germany), E. TIEFENBACHER (Daimler-Benz AG, Stuttgart, West Germany), and P. WALZER (Volkswagenwerk AG, Wolfsburg, West Germany). American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 11 p. Research sponsored by the Bundesministerium fuer Forschung und Technologie.  
(ASME PAPER 83-GT-205)

In 1974, the West German Ministry of Research and Technology initiated a research program for the development of vehicular gas turbine ceramic component technology. Attention is given to the results obtained to date with such components as a combustion chamber, nozzles, and two types of turbine rotors, as well as to the relative merits of silicon carbide and silicon nitride as component materials subjected to severe, durability-taxing conditions. O.C.

#### A83-48007#

##### X-RAY TOMOGRAPHY APPLIED TO NDE OF CERAMICS

J. W. KRESS and L. A. FELDKAMP (Ford Motor Co., Dearborn, MI). American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 5 p. refs  
(Contract N00014-78-C-0714)  
(ASME PAPER 83-GT-206)

An X-ray radiographic nondestructive evaluation system is developed which is specifically suited to three-dimensional tomographic reconstruction. The system uses video technology to image the X-ray projection of a specimen generated by a microfocus X-ray source and fluorescent screen. The use of a

three-dimensional reconstruction algorithm with this system is examined. Results are presented for the use of this system in two applications. The first is the reconstruction of a section of a ceramic gas turbine rotor blade, which demonstrates that the system has the capability to reconstruct parts with complex external shapes. The second application examines the assembly of ceramic components containing a 50 micron gap. It is found that this method is able to reconstruct the components with clear detection of the 50 micron spacers and void regions. N.B.

#### A83-48017#

##### AN INVESTIGATION INTO THE EFFECT OF COOLANT FLOW ON THE VIBRATION CHARACTERISTICS OF HOLLOW BLADES CONVEYING FLUID

B. A. ABUID and A. M. AL-JUMAILY (Baghdad, University, Baghdad, Iraq). American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs  
(ASME PAPER 83-GT-217)

This paper treats the free vibration of hollow symmetrical turbo-machinery blades conveying cooling fluid. The blade motion is described by using a simplified shell theory, whereas the fluid forces are described by the linearized potential flow theory. Natural frequencies are presented for the axial and circumferential modes and the effect of flow velocity and other parameters are discussed. Two models are constructed and tested with air and water as the flowing fluid. Also a beam approximation is used to justify the results at least in a qualitative manner. Experimental data and theoretical results are in good agreement and they all show that the fluid flow tends to decrease the free vibration-natural frequencies. Author

#### A83-48020#

##### GAS TURBINE PERFORMANCE IMPROVEMENT BY RETROFIT OF ADVANCED TECHNOLOGY

V. C. TANDON and A. ZABRODSKY, SR. (Westinghouse Electric Corp., Combustion Turbine Systems Div., Concordville, PA). American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 6 p.  
(ASME PAPER 83-GT-222)

After an initial use of smaller machines, user needs have continued to grow for larger and more dependable machines. The evolution of larger size machines makes it possible to develop upgrades by applying evolutionary advances in technology to earlier production engines. A stepwise improvement in model performance could be realized due to advances in turbine cooling technology, the application of better materials, the addition of cooling to row 2 turbine blades, increased cooling in upstream stages, and material changes as required for higher turbine inlet temperature. G.R.

#### A83-48021#

##### STRAIN ISOLATED CERAMIC COATINGS

R. P. TOLOKAN, J. B. BRADY, and G. P. JARRABET (Brunswick Corp., Technetics Div., DeLand, FL). American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 7 p. refs  
(ASME PAPER 83-GT-223)

The durability of thermally shocked high temperature ceramic coatings on metal substrates can be dramatically improved using a fiber metal strain isolator between ceramic and metal. The fiber metal strain isolator is a compliant, porous and low modulus material which yields to control the stress on the ceramic coating during thermal cycling. Plasma sprayed strain isolated ceramic coatings 1.5 mm thick have shown excellent durability in thermal shock testing. The strain isolated ceramic coating is an excellent thermal barrier since both the ceramic and fiber metal are good insulators. Applications include ceramic thermal barrier coatings for gas turbine engine seals and turbine components, combustors, MHD electrodes, and internal combustion engine insulation. Author

**A83-48023\*#** Detroit Diesel Allison, Indianapolis, Ind.  
**COMPONENT QUALIFICATION AND INITIAL BUILD OF THE AGT 100 ADVANCED AUTOMOTIVE GAS TURBINE**  
 R. A. JOHNSON (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 9 p. Research supported by the U.S. Department of Energy. refs  
 (Contract DEN3-168)  
 (ASME PAPER 83-GT-225)

In advance of initial dynamometer testing of the AGT 100 engine, all prime components and subsystems were bench/rig tested. Included were compressor, combustor, turbines, regenerator, ceramic components, and electronic control system. Results are briefly reviewed. Initial engine buildup was completed and rolled-out for test cell installation in July 1982. Shakedown testing included motoring and sequential firing of the combustor's three fuel nozzles. Author

**A83-48025\*#** Mechanical Technology, Inc., Latham, N. Y.  
**POWER TURBINE DYNAMICS - AN EVALUATION OF A SHEAR-MOUNTED ELASTOMERIC DAMPER**  
 E. S. ZORZI, J. WALTON (Mechanical Technology, Inc., Latham, NY), and R. CUNNINGHAM (NASA, Lewis Research Center, Cleveland, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 6 p. refs  
 (Contract NAS3-21623; NAS3-20609)  
 (ASME PAPER 83-GT-228)

As an alternative to the more conventional squeeze-film bearing damper designs, a Viton-70 shear-mounted, elastomeric damper was built and tested in a T-55 power turbine high-speed balancing rig. This application demonstrated, for the first time, the feasibility of using elastomers as the primary rotor damping source in production turbine engine hardware. The shear-mounted damper design was selected because of its compatibility with actual gas turbine engine radial space constraints, its accommodation of both the radial and axial thrust loads present in gas turbine engines, and its capability of controlled axial preload. Test results showed that the Viton-70 elastomeric damper operated successfully and provided excellent control of both synchronous and nonsynchronous vibrations through all phases of testing to the maximum rotor speed of 1676 rad/s (16,000 rpm). Excellent correlation between the predicted and experienced critical speeds, mode shapes, and log decrements for the power turbine rotor and elastomer damper assembly was also achieved. Author

**A83-48026#**  
**GAS TURBINE COMPRESSOR INTERSTAGE COOLING USING METHANOL**  
 J. A. C. FORTIN and M. F. BARDON (Royal Military College of Canada, Kingston, Ontario, Canada) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 5 p. refs  
 (ASME PAPER 83-GT-230)

An earlier study demonstrated the theoretical potential of the concept of injecting methanol into a gas turbine compressor inlet as a means of increasing cycle thermal efficiency. To attain the full potential of such a system, continuous shifting vapor/liquid equilibrium is required which would pose formidable difficulties in practice due to the presence of liquid in the compressor blading. This study evaluates a more practicable configuration in which the alcohol is injected between stages of a multi-stage machine so that, due to the higher air temperatures, evaporation is complete before the mixture enters subsequent stages. Through a computer analysis, it is shown that this arrangement would retain most of the potential of the concept while greatly reducing the design and operating problems. Author

**A83-48030\*#**  
**PROGRESS IN NET SHAPE FABRICATION OF ALPHA SIC TURBINE COMPONENTS**  
 R. S. STORM and R. G. NAUM (Carborundum Resistant Materials Co., Niagara Falls, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 28th, Phoenix, AZ, Mar. 27-31, 1983. 6 p. Research supported by the U.S. Department of Energy.  
 (Contract DEN3-17; DEN3-168; DEN3-167)  
 (ASME PAPER 83-GT-238)

The development status of component technology in an automotive gas turbine Ceramic Applications in Turbine Engines program is discussed, with attention to such materials and processes having a low cost, net shape fabrication potential as sintered alpha-SiC that has been fashioned by means of injection molding, slip casting, and isostatic pressing. The gas turbine elements produced include a gasifier turbine rotor, a turbine wheel, a connecting duct, a combustor baffle, and a transition duct. O.C.

**A83-48306**  
**FABRICATION OF COMPLEX SHAPED CERAMIC ARTICLES BY SLIP CASTING AND INJECTION MOLDING**  
 J. A. MANGELS (Ford Motor Co., Ceramic Materials Dept., Dearborn, MI) IN: Progress in nitrogen ceramics; Proceedings of the Second Advanced Study Institute, Brighton, England, July 27-August 7, 1981. Boston, MA and The Hague, Martinus Nijhoff Publishers, 1983, p. 711-715; Discussion, p. 715. refs

**A83-48350#**  
**CONSOLIDATED TPS IMPLEMENTATION TODAY AND TOMORROW**  
 W. YOUNG (Bendix Corp., Test Systems Div., Teterboro, NJ) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 5 p.  
 (AIAA PAPER 83-2495)

It is pointed out that the development of quality Test Program Sets (TPS) is very costly. The present investigation is concerned with a consolidated interactive integrated (CII) approach to TPS development. According to the CII procedure, the various aids, expertise, and information needed to produce quality TPSs are brought into a single environment. The CII TPS development concept makes it possible to provide high quality, uniform, consistent, and comprehensive TPSs at lower development time and cost with a very high assurance of operability and completeness prior to validation. Attention is given to the background of TPS design and development, the program composing terminal, the CII TRD (Test Requirements Document) development concept, the CII TRD development system, external links, and systems benefits. G.R.

**A83-48353#**  
**NEW CONCEPTS FOR INTERMEDIATE LEVEL MAINTENANCE**  
 P. HOGAN (Honeywell, Inc., Minneapolis, MN) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 8 p.  
 (AIAA PAPER 83-2498)

It is pointed out that intermediate level maintenance of complex avionics equipment has become a major problem for the military. The present investigation is concerned with some basic flaws in the current approach to intermediate level Automatic Test Equipment (ATE), taking into account the possibility that new concepts may help to reduce the maintenance problem. Problems concerning avionics maintenance began to appear in the late 1950s, when the old manual testing methods were no longer adequate to maintain increasingly complex systems. The ATE was introduced to solve these problems. Currently great problems have arisen in connection with the complexity of ATE and test programs. Solutions to these problems are discussed. Attention is given to a near-term approach related to the use of a portable-configurable ATE, and a long-term approach, involving the utilization of new advances in circuit technology and avionics design. The long-term

approach is Two-Level maintenance which will completely eliminate intermediate level testing. G.R.

**A83-48679#****THE BASIC AERODYNAMICS OF FLOATATION**

M. J. DAVIES (John Lysaght /Australia/, Ltd., Port Kembla, Australia) and D. H. WOOD (Newcastle, University, Newcastle, Australia) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 105, Sept. 1983, p. 323-328. Research supported by John Lysaght, Ltd. refs

It is pointed out that the basic aerodynamics of modern floatation ovens, in which the continuous, freshly painted metal strip is floated, dried, and cured, is the two-dimensional analog of that of hovercraft. The basic theory for the static lift considered in connection with the study of hovercraft has had spectacular success in describing the experimental results. This appears surprising in view of the crudity of the theory. The present investigation represents an attempt to explore the reasons for this success. An outline of the basic theory is presented and an approach is shown for deriving the resulting expressions for the lift from the full Navier-Stokes equations in a manner that clearly indicates the limitations on the validity of the expressions. Attention is given to the generally good agreement between the theory and the axisymmetric (about the centerline) results reported by Jaumotte and Kiedrzyński (1965). G.R.

**A83-48890#****INTEGRATED DIGITAL AVIONIC SYSTEMS - PROMISE AND THREATS**

B. A. ZEMPOLICH (U.S. Naval Air Systems Command, Washington, DC) Astronautics and Aeronautics (ISSN 0004-6213), vol. 21, Oct. 1983, p. 46-53.

The progress being made in effective systems design implementation for digital equipment for aircraft avionics systems is assayed. The history of digital systems integration in avionics hardware is traced from use of 16-transistor chips to emerging 100,000 gate chips, and attention is given to architectural considerations for future hardware. Design considerations include top-down or bottom-up architecture, distributed microprocessor and computer resources, integrated components or data fusion, etc. Systems decomposition practices in design permit separate design of flight safety systems, redundancy, fault tolerance, and identifying components that feature different technologies. Present flight control systems sport a MBTF of 1,000,000 hr when separate controls are installed for each flight system. D.H.K.

**A83-49188\*** Virginia Polytechnic Inst. and State Univ., Blacksburg.

**STRUCTURAL OPTIMIZATION WITH AEROELASTIC CONSTRAINTS - A SURVEY OF US APPLICATIONS**

R. T. HAFTKA (Virginia Polytechnic Institute and State University, Blacksburg, VA) IN: International Symposium on Aeroelasticity, Nuremberg, West Germany, October 5-7, 1981, Collected Papers. Cologne, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1982, p. 179-186. refs (Contract NSG-1266)

The paper describes recent developments in the United States in the application of structural optimization techniques to problems of design under aeroelastic constraints. The material is divided into sections on: (1) conventional strength design using aeroelastically calculated loads; (2) aeroelastic tailoring for improved performance; (3) design under flutter and static aeroelastic constraints; and (4) miscellaneous applications. Because of the high cost of applying formal optimization techniques to practical design problems, there have been very few applications of structural optimizations to actual aircraft. The paper is focused on trends that may eventually reverse this situation. Author

**A83-49416#****FLOW VISUALIZATION BY LIGHT SHEET**

C. VERET (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (International Symposium on Flow Visualization, 3rd, Ann Arbor, MI, Sept. 6-9, 1983) ONERA, TP, no. 1983-105, 1983, 8 p. (ONERA, TP NO. 1983-105)

The experimental set-up results of using a light sheet to reveal the structures in wind tunnel flows seeded with smoke are described. A laser beam is reflected down to a glass rod that acts as cylindrical lens and spreads the beam into planar shape. The sheet can be swept across the flow in a parallel direction or rotated to the vertical by reorienting the glass rod. Images are captured by a television camera or a movie camera. The technique has been used to examine vortices in flows, in the wake over a model or a delta wing, in swirling flows, and to clearly reveal flow boundaries. M.S.K.

**A83-49599\*** Lockheed Engineering and Management Services Co., Inc., Houston, Tex.

**GREEN'S FUNCTION SOLUTION AND APPLICATIONS FOR CRACKS EMANATING FROM A CIRCULAR HOLE IN AN INFINITE SHEET**

V. SHIVAKUMAR (Lockheed Engineering and Management Services Co., Houston, TX), R. G. FORMAN, and R. ROSENCRANZ, JR. (NASA, Johnson Space Center, Houston, TX) Res Mechanica (ISSN 0143-0084), vol. 9, no. 2, 1983, p. 87-104. refs

Stress-intensity factors are obtained for point loaded equal length cracks emanating from a circular hole in an infinite plate. A series approach and the Muskhelishvili formulation in the two-dimensional theory of elasticity are used to derive the solution. The applicability of the solution is demonstrated by using it as a Green's function to obtain stress-intensity factors in the case of (1) biaxial tension and pure shear of an infinite plate and (2) tension and pin loading of a plate with cracks emanating from one hole in a row of holes. Author

**A83-49667****INVESTIGATION OF UNSTEADY TEMPERATURE FIELDS OF NONAXISYMMETRIC NOZZLE INSERTS [ISSLEDOVANIJE NESTATSIONARNYKH TEMPERATURNYKH POLEI NEOSIMMETRICHNYKH SOPLOVYKH VKLADYSHEI]**

L. G. MAKARENKOVA Kosmicheskie Issledovaniia na Ukraine (ISSN 0321-4508), no. 16, 1982, p. 63-66. In Russian.

The problem of calculating unsteady heat-conduction in an eccentric nozzle insert subjected to intense heating is considered with reference to the thrust vector control of supersonic flight vehicles. The third boundary value problem of unsteady heat-conduction is solved analytically for an eccentric ring. Results of calculations are presented for a nozzle insert of small eccentricity, and a comparison is made with finite-difference results. B.J.

**A83-50138#****FORCE-TRANSMITTING STRUCTURES IN BLADES FOR HELICOPTER ROTORS, WIND-TUNNEL BLOWERS, AND WIND TURBINES [KRAFTLEITUNGEN IN BLÄTTER FÜR ROTOREN VON HUBSCHRAUBERN, WINDKANALGEBLÄSEN UND WINDTURBINEN]**

M. HAHN and H. RAPP (Messerschmitt-Boelkow-Blohm GmbH, Unternehmensbereich Drehflügler und Verkehr, Munich, West Germany) Deutsche Gesellschaft fuer Luft- und Raumfahrt, Symposium ueber Entwicklung und Anwendung von CFK-Strukturen, Stuttgart, West Germany, May 26, 27, 1982. 26 p. In German. refs (DGLR PAPER 82-013)

The design of attachment structures for GFRP, CFRP, or hybrid-composite rotor blades is discussed. The application of one-loop, two-loop, or continuous-belt constructions is illustrated with examples and test results from the development program of the BO-105 jointless helicopter rotor. The bolted-woven-laminate construction is shown to be best adapted to wind-tunnel and

wind-energy-conversion applications where wider distribution of the load is desirable and mechanically feasible. The advantages gained by a prestressed screw connection are demonstrated by the blades for the Emmen, Switzerland, wind tunnel. T.K.

**A83-50145\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**RECENT APPLICATIONS OF A LASER VELOCIMETER IN THE LANGLEY 4BY 7-METER WIND TUNNEL**

W. L. SELLERS, III (NASA, Langley Research Center, Hampton, VA) and J. W. ELLIOTT (U.S. Army, Army Structures Laboratory, Hampton, VA) Biennial Symposium on Turbulence, 8th, University of Missouri-Rolla, Rolla, MO, Sept. 26-28, 1983, Paper. 10 p. refs

A long focal length laser velocimeter (LV) has become a production measurement tool in the Langley 4- by 7-Meter Tunnel. Two recent applications of the LV include flowfield measurements: (1) in the wake of a helicopter, and (2) around the wing of an aspect-ratio (AR) 7 wing-body model. A discussion of these two applications is provided along with a description of the flowfields in terms of the mean velocities and turbulence intensities.

Author

**N83-35318\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**VORTEX MOTION IN AXISYMMETRIC PISTON-CYLINDER CONFIGURATIONS**

T. I. P. SHIH, G. E. SMITH, and G. S. SPRINGER Sep. 1982 22 p refs Backup document for AIAA Synoptic scheduled for publication in AIAA Journal in Mar. 1984 Prepared in cooperation with Michigan Univ., Ann Arbor and Florida Univ., Gainesville (NASA-TM-85404; NAS 1.15:85404) Avail: NTIS HC A02/MF A01 CSCL 20D

By using the Beam and Warming implicit-factored method of solution of the Navier-Stokes equations, velocities were calculated inside axisymmetric piston cylinder configurations during the intake and compression strokes. Results are presented in graphical form which show the formation, growth and breakup of those vortices which form during the intake stroke by the jet issuing from the valve. It is shown that at bore-to-stroke ratio of less than unity, the vortices may breakup during the intake stroke. It is also shown that vortices which do not breakup during the intake stroke coalesce during the compression stroke. S.L.

**N83-35404#** Curtiss-Wright Corp., Wood-Ridge, N.J.

**HIGH-TEMPERATURE-TURBINE TECHNOLOGY PROGRAM. PHASE 2: TECHNOLOGY TEST AND SUPPORT STUDIES. TRANSPIRATION COOLED TURBINE VANE AERODYNAMIC CASCADE RESULTS AND ANALYSIS**

Feb. 1983 136 p refs  
(Contract DE-AC01-76ET-10348)  
(DE83-010307; CW-WR-76-020.108A; FE-2291-108A) Avail: NTIS HC A07/MF A01

The aerodynamic performance of a turbine vane using transpiration air cooling (TAC) and a vane of identical profile with no cooling provisions to determine the effect of cooling on vane kinetic energy efficiency and loss coefficient were determined. The test configuration was a 600, 10 vane section of a first stage turbine stator designed for 1.6 pressure ratio, cooling air flow equal to 6.1% of primary flow, 30000F turbine inlet temperature, and primary to coolant temperature ratio of 2.7. Tests were conducted at three pressure ratios, three coolant flows, and 120% of design, and three primary to coolant temperature ratios. Efficiency, loss coefficient, and flow capacity test results are in good agreement with predicted values for both the TAC and uncooled vanes. It is demonstrated that it is necessary to conduct test evaluations of transpiration air cooled components at or near design coolant to gas stream temperature ratio in order to achieve correct results.

DOE

**N83-35416#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.

**UNSYMMETRIC LAMINATED GRAPHITE/EPOXY COMPOSITE PLATE AND BEAM ANALYSIS FOR DETERMINING COEFFICIENTS OF THERMAL EXPANSION M.S. Thesis**

S. T. DENNIS Feb. 1983 120 p refs  
(AD-A128625; AFIT/CI/NR-83-5T) Avail: NTIS HC A06/MF A01 CSCL 12A

This thesis investigates the properties of unsymmetrically stacked layers of composite plies, in particular their thermal behavior. Starting with simple stress-strain relationship, the underlying governing equations were developed. These were tested experimentally.

Author (GRA)

**N83-35426#** Societe Nationale Industrielle Aerospatiale, Suresnes (France). Lab. Central.

**CONSTRUCTION OF A NATURAL ENVIRONMENT AGING MACHINE WITH INDEPENDENT ENERGY SUPPLY, FOR LOAD CYCLES ON AIRCRAFT STRUCTURES [REALISATION D'UNE MACHINE DE VIEILLISSEMENT EN AMBIANCE NATURELLE, AUTONOME ENERGETIQUEMENT ET PERMETTANT D'EFFECTUER DES CYCLES DE CHARGE SUR DES ASSEMBLAGES DU TYPE AVION]**

M. D. ALIAGA 21 Dec. 1982 14 p In FRENCH Presented at SURFAIR 4 Conf. Journees d'Etudes Intern. de Traitements de Surfaces dans l'Ind. Aeron. et Spatiale, Cannes, France, 29-30 Sep.-1 Oct. 1982

(SNIAS-831-551-101; C.41.325) Avail: NTIS HC A02/MF A01

A tensile stress testing machine was built for autonomous operation on an island. Tests up to 100 MPa can be performed, with intermittent relaxation to test joints. The apparatus is based on the differential expansion of two beams: one is heated by the Sun, the other remains cold. A lever increases the separation between the beams. Test samples form a third beam. When all three have the same temperature the samples are stretched. When the hot beam expands, stress on the samples is reduced.

Author (ESA)

**N83-36312#** Sperry Research Center, Sudbury, Mass.

**POLARIZATION NULL CHARACTERISTICS OF SIMPLE TARGETS Final Technical Report, 26 Aug. 1981 - 25 Aug. 1982**

H. MIERAS, R. M. BARNES, G. M. VACHULA, J. N. BUCHNAM, C. L. BENNETT, and W. M. BOERNER Griffiss AFB, N.Y. RADC Jan. 1983 254 p refs  
(Contract F30602-81-C-0254)  
(AD-A129303; RADC-TR-82-335; SRC-CR-82-33) Avail: NTIS HC A12/MF A01 CSCL 17I

The polarization null and maximum characteristics of simple compound targets are studied; with the objective of assessing the applicability of these concepts to target discrimination. The polarization characteristics of single scattering centers are derived in theoretical detail and shown to be highly distinctive according to scattering center type. However, the dynamic behavior of the characteristics with changing aspect for compound targets is shown to be very complex. It is concluded that these concepts are not generally useful for target discriminations if an extended target is viewed at a single frequency. Extension are suggested to make the approach useful.

Author

**N83-36338#** Rome Air Development Center, Griffiss AFB, N.Y. **PROCEEDINGS OF THE ANTENNA APPLICATIONS SYMPOSIUM (1982)**

Jan. 1983 686 p refs Symp. held at Urbana, Ill., 22-24 Sep. 1982  
(Contract AF PROJ. 4600)  
(AD-A129356; RADC-TR-82-339) Avail: NTIS HC A99/MF A01 CSCL 09E

The Proceedings of the 1982 Antenna Applications Symposium is a collection of the State-of-the-Art papers relating to Phased Array Antennas, Millimeter Wave Antennas, Microstrip and Conformal Antennas and Reflector Antennas.

Author (GRA)

## 12 ENGINEERING

**N83-36352#** National Telecommunications and Information Administration, Annapolis, Md.

### **BACKGROUND STUDY ON EFFICIENT USE OF THE 2700-2900 MHZ BAND**

R. L. HINKLE Mar. 1983 150 p refs  
(PB83-214288; NTIA/REPT-83-117) Avail: NTIS HC A07/MF A01 CSCL 171

The report on the 2700-2900 MHz band provides background information and summarizes the findings on tasks assigned to the Interdepartment Radio Advisory Committee (IRAC) Technical Subcommittee by the IRAC (IRAC Doc. 21572). Equipment characteristics, radar deployment patterns, usage of the band based on Radio Spectrum Measurement System (RSMS) van measurements, and projected usage of the band in the 1980's are discussed. Also the accommodation of new systems planned for the band was studied. Based on the projected growth in the band and present and projected radar deployment patterns, recommendations were made to the IRAC which would enhance the accommodation of new systems planned for the band.

Author (GRA)

**N83-36372#** Boeing Aerospace Co., Seattle, Wash.  
**HIGH VOLTAGE DESIGN GUIDE. VOLUME 4: AIRCRAFT Final Report, 29 Sep. 1979 - 5 Jan. 1983**

W. G. DUNBAR Wright-Patterson AFB, Ohio AFWAL Jan. 1983 244 p refs 4 Vol.  
(Contract F33615-79-C-2067; AF PROJ. 3145)  
(AD-A129530; AFWAL-TR-82-2057-VOL-4) Avail: NTIS HC A11/MF A01 CSCL 10B

This report supplies the theoretical background and design techniques needed by an engineer who is designing electrical insulation for high-voltage, high-power components, equipment, and systems for aircraft. A literature survey and abundant bibliography identify references that provide further data on the subjects of partial discharges, corona, field theory and plotting, voids and processes for applying insulation. Both gaseous and solid insulations are treated. Cryogenic and liquid design notes are included. Tests and test equipment for high voltage insulation and equipment are defined. Requirements of test plans and procedures for high-voltage, high-power equipment are identified and illustrated by examples. Suggestions for high-voltage specifications are provided. Very few of the Military and Government specifications deal with system voltages above 10kV, thus most aircraft high-voltage specifications will have to be derived from the power industry specifications and standards produced by ASTM, IEEE, and NEMA.

GRA

**N83-36396#** Japan Society for Aeronautical and Space Sciences, Tokyo.

### **TRANSACTIONS OF THE JAPAN SOCIETY FOR AERONAUTICAL AND SPACE SCIENCES, VOL. 25, NO. 68**

H. TAKATA, ed. Aug. 1982 61 p refs  
(ISSN-0549-3811) Avail: NTIS HC A04/MF A01

Three articles on fluid flow are presented. Development of an axial flow turbine and a simplified algorithm for apogee boost motor sizing are also discussed.

**N83-36401#** National Aerospace Lab., Tokyo (Japan). Second Aerodynamic Div.

### **A NUMERICAL STUDY OF FLOW PAST A ROTATING FLAT PLATE BY THE DISCRETE VORTEX METHOD**

Y. ISHIDA In Japan Society for Aeronautical and Space Sciences Trans. of the Japan Soc. for Aeron. and Space Sci., Vol. 25, No. 68 p 114-125 Aug. 1982 refs Original language document was announced as A82-47071  
Avail: NTIS HC A04/MF A01

Flow past a flat plate rotating about an axis perpendicular to the main flow was examined using the discrete vortex method. Vortices enter the flowfield at fixed positions around the plate edges at an angular interval of six deg, with strengths determined by the Kutta condition. Consideration is given to an impulsive start-up of the plate, rotation with a constant angular speed, for a change in the spin parameter, and with various vortex reduction

factors. Time dependent alterations of lift, drag, and moment are derived, as are the vortex flow pattern and the streamlines. The results are shown to agree well with experimental data.

M.S.K. (IAA)

**N83-36499#** Argonne National Lab., Ill. Energy and Environmental Systems Div.

### **A STRUCTURAL-CERAMIC RESEARCH PROGRAM: A PRELIMINARY ECONOMIC ANALYSIS**

L. R. JOHNSON, A. P. S. TEOTIA, and L. G. HILL Mar. 1983 81 p refs  
(Contract W-31-109-ENG-38)

(DE83-014263; ANL/CNSV-38) Avail: NTIS HC A05/MF A01

The macroeconomic impacts (effects on gross national product, employment, fuel imports, and balance of trade) were modeled for two scenarios, one in which the US dominates the commercialization of ceramics in heat engines throughout the 1990s and the other in which Japan dominates. The positive effects of US dominance were forecast to be substantially greater than the negative effects of foreign dominance due to two assumptions: (1) Japanese ceramic commercialization does not include the truck and stationary engine markets because of a lack of historical presence in these areas and (2) imports of Japanese cars with ceramic engines are legislatively limited to 30% of new car sales. It is found that improved ceramics can also be substituted for superalloys containing strategic materials and thus reduce US dependence on foreign suppliers.

DOE

**N83-36509\*#** Maine Univ., Orono.

### **FATIGUE BEHAVIOR OF ADHESIVELY BONDED JOINTS Final Report**

S. MALL 31 Aug. 1983 11 p refs

(Contract NCC1-70)

(NASA-CR-174458; NAS 1.26:174458) Avail: NTIS HC A02/MF A01 CSCL 20K

The fatigue damage mechanism of composite to composite adhesively bonded joints was characterized. The mechanics of the possible modes of fatigue damage propagation in these joints when subjected to constant amplitude cyclic mechanical loading were investigated. The possible failure modes in composite bonded joints may be cyclic debonding (i.e., progressive separation of the adhesive), interlaminar damage (delamination), adherend fatigue or a combination of these. Two composite systems - graphite/epoxy adhesively bonded to graphite/epoxy and Kevlar 49/epoxy adhesively bonded to Kevlar 49/epoxy were investigated. Both composite systems consisted of quasi-isotropic lay-ups, i.e., 0 deg/-45 deg/+45 deg/90 degs. The two adhesives, employed in the study were (1) EC 3445 with cure temperature of 250 F for secondary bonding and (2) FM 300 with cure temperature of 350 F for co-cure bonding.

S.L.

## 13

## GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

**A83-48225#**

### **WIND SHEAR - A DANGER FOR FLIGHT [LO SHEAR DEL VENTO - UN PERICOLO PER IL VOLO]**

M. BASSANI (Aeronautica Militare, Servizio Meteorologico, Rome, Italy) Rivista di Meteorologia Aeronautica (ISSN 0035-6328), vol. 43, Jan.-June 1983, p. 75-81. In Italian. refs

The characteristics and causes of wind-shear phenomena are reviewed, and possible methods for their real-time detection are explored. Vertical and horizontal shear forces at microscale, mesoscale, and synoptic scale are compared, and the horizontal mesoscale shear is shown to be most dangerous to aircraft. The



meteorological factors involved in the generation of horizontal mesoscale wind shear are discussed, and the difficulty of predicting them with current numerical models is illustrated. A critical horizontal-shear value of 0.1 kt/m is suggested. The detection systems Sodar (sound detection and ranging), laser Doppler, microwave Doppler radar, and low-level wind-shear alert system (LLWSAS) are characterized; and the microwave radar system is found to provide the most information on the location and possible causes of a horizontal shear in the vicinity of an airport. T.K.

#### A83-49691

##### **EVIDENCE FOR THE PRODUCTION OF ICE PARTICLES IN CLOUDS DUE TO AIRCRAFT PENETRATIONS**

P. V. HOBBS and A. L. RANGNO (Washington, University, Seattle, WA) IN: Conference on Cloud Physics, Chicago, IL, November 15-18, 1982, Preprints. Boston, MA, American Meteorological Society, 1982, p. 107-110. NOAA-supported research. (Contract NSF ATM-79-00948)

Preliminary evidence that aircraft flying through a supercooled cloud produce AIPs (aircraft-produced ice particles) is presented. Data from fourteen flights through cumulus turrets along paths that were previously sampled are analyzed, showing that ice particles were observed on the second pass where none were observed on the original pass. Ice particles were also not detected on flights through different regions of the clouds when the flights did not pass over a previously flown path. Dry ice seeding also produced ice particle formation, but over a larger region than the cylindrical track left by the aircraft with no dry ice seeding apparatus. Further studies are recommended to identify the exact mechanism of AIPs formation. M.S.K.

#### A83-49698

##### **AIRCRAFT OBSERVATIONS OF LARGE SCALE CLOUD SYSTEMS**

I. D. COHEN (USAF, Geophysics Laboratory, Bedford, MA) IN: Conference on Cloud Physics, Chicago, IL, November 15-18, 1982, Preprints. Boston, MA, American Meteorological Society, 1982, p. 203-206. USAF-supported research. refs (AD-A122515; AFGL-TR-82-0343)

The three storm systems investigated occurred on March 1-3, 1978, March 23-27, 1978, and April 10-12, 1979. Comparisons are made of size distributions from different levels and on different days. In general, the upper levels exhibited the greatest consistency in particle size and shape. In the majority of cases, the highest altitude flown was near the 400 millibar surface (about 7 km). In all cases, convective activity was pronounced on the first day of the storm. The storm of March 23-27 provided the best example of a storm changing from a primarily convective to a primarily stratiform system. C.R.

#### N83-36570# Air Force Geophysics Lab., Hanscom AFB, Mass. (?) THE AIR FORCE GEOPHYSICS LABORATORY: AERONOMY, AEROSPACE INSTRUMENTATION, SPACE PHYSICS, METEOROLOGY, TERRESTRIAL SCIENCES AND OPTICAL PHYSICS Interim Scientific Report

A. B. MCGINTY Apr. 1982 226 p (Contract AF PROJ. 9993) (AD-A126004; AFGL-TR-82-0132; SR-230) Avail: NTIS HC A11/MF A01 CSCL 05A

Contents: The Air Force Geophysics Laboratory; Aeronomy Division--Upper Atmosphere Composition, Middle Atmosphere Effects, Atmospheric UV Radiation, Satellite Accelerometer Density Measurement, Theoretical Density Studies, Chemical Transport Models, Turbulence and Forcing Functions, Atmospheric Ion Chemistry, Energy Budget Campaign, Kwajalein Reference Atmospheres, 1979, Satellite Studies of the Neutral Atmosphere, Satellite Studies of the Ionosphere, Aerospace Instrumentation Division--Sounding Rocket Program, Satellite Support, Rocket and Satellite Instrumentation; Space Physics Division--Solar Research, Solar Radio Research, Environmental Effects on Space Systems, Solar Proton Event Studies, Defense Meteorological Satellite Program, Ionospheric Effects Research, Spacecraft Charging Technology; Meteorology Division--Cloud Physics, Ground-Based

Remote-Sensing Techniques, Mesoscale Observing and Forecasting, Design Climatology, Aircraft Icing Program, Atmospheric Dynamics; Terrestrial Sciences Division--Geodesy and Gravity, Geokinetics; Optical Physics Division--Atmospheric Transmission, Remote Sensing, Infrared Background; and Appendices. GRA

N83-36592\*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

##### **LOW-LEVEL GUST GRADIENT PROGRAM AND AVIATION WORKSHOP EFFORT**

W. FROST, M. C. LIN, L. W. HERSHAM, D. W. CAMP, and W. CAMPBELL In its NASA/MFSC FY-83 Atmospheric Res. Rev. p 16-17 Oct. 1983 refs Prepared in cooperation with Tennessee Univ. Space Inst, Tullahoma Avail: NTIS HC A03/MF A01 CSCL 04B

The Proceedings of the Workshop on Meteorological and Environmental Inputs to Aviation Systems, hosted by the University of Tennessee Space Institute, October 26-28, 1982, were prepared for publication. The Proceedings were submitted to FAA and will be distributed by August. Also, the proceedings of a one day workshop devoted specifically to wind shear and hosted during the same time frame were prepared and distributed. Plans for the 1983 workshop are proceeding extremely well. The workshop theme was established, the committee topics identified, and all ten committee chairmen contacted have agreed to accept their respective assignments. Additional logistics for the workshop are being carried out. The 1983 workshop is scheduled for October 26-28, 1983. Data gathered with the B-57B during the Joint Airport Weather Studies Project in Denver, Colorado, were analyzed. All runs for Flight 6 on July 16, 1982, were analyzed. Spectra, cross spectra and probability distributions were computed for each run. Also, Runs 10-14 of Flight 7 on July 15, 1982, were analyzed in similar detail. R.J.F.

N83-36593\*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

##### **FEASIBILITY STUDY OF A PROCEDURE TO DETECT AND WARN OF LOW-LEVEL WIND SHEAR**

W. FROST (FWG Associates, Inc.) and D. W. CAMP In its NASA/MFSC FY-83 Atmospheric Res. Rev. p 18-19 Oct. 1983 refs

Avail: NTIS HC A03/MF A01 CSCL 04B

The wind shear program is directed toward investigating the effects of wind shear on aerodynamic performance. Combining the Joint Airport Weather Studies wind shear data with the B-57B gust gradient data, the transient scales of motion involved in wind shear aircraft accidents or mishaps are being identified. The effect of variable winds having these time scales on the aerodynamic coefficients of moist airfoils were fully investigated. Transient and spatial variation of flow over the airfoil may cause premature stall or hysteresis effects which significantly impact the lift and drag (i.e., aerodynamic coefficients). Analysis of airfoil performance subject to 4-D variable flows will be carried out. R.J.F.

N83-36595\*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

##### **LOW-LEVEL FLOW CONDITIONS HAZARDOUS TO AIRCRAFT**

M. B. ALEXANDER and D. W. CAMP In its NASA/MFSC FY-83 Atmospheric Res. Rev. p 22-23 Oct. 1983 refs

Avail: NTIS HC A03/MF A01 CSCL 04B

Low level flow conditions known to be hazardous to aircraft during takeoff/climbout and approach/landing operations are turbulence, wind shear, and vertical motion. These conditions can and frequently do occur separately and in combinations. The identification and selection were completed of representative data cases to determine magnitude, frequency, duration, and simultaneity of occurrence of turbulence (gustiness and gust factor), wind shear (speed and direction), and vertical motion (updraft and downdraft), along with temperature inversions. New representations of temporal and spatial variations in the atmospheric boundary layer were developed. Efforts continued relative to low level flow conditions where published results imply strong vertical shear with

virtually no horizontal shear and where order of magnitude analyses of the equations of motion for an aircraft illustrates that low values of horizontal shear (along the flight path) are much more hazardous than larger values of vertical wind shear (altitude). R.J.F.

**N83-36598\*#** Dayton Univ., Ohio.

**A MODEL FOR NOCTURNAL FROST FORMATION ON A WING SECTION: AIRCRAFT TAKEOFF PERFORMANCE PENALTIES Final Report**

M. A. DIETENBERGER Washington NASA Oct. 1983 95 p refs

(Contract NAS8-33369)

(NASA-CR-3733; NAS 1.26:3733) Avail: NTIS HC A05/MF A01 CSCI 04B

The nocturnal frost formation on a wing section, to explain the hazard associated with frost during takeoff was investigated. A model of nocturnal frost formation on a wing section which predicts when the nocturnal frost will form and also its thickness and density as a function of time was developed. The aerodynamic penalties as related to the nocturnal frost formation properties were analyzed to determine how much the takeoff performance would be degraded by a specific frost layer. With an aircraft takeoff assuming equations representing a steady climbing flight, it is determined that a reduction in the maximum gross weight or a partial frost clearance and a reduction in the takeoff angle of attack is needed to neutralize drag and life penalties which are due to frost. Atmospheric conditions which produce the most hazardous frost buildup are determined. E.A.K.

**N83-36615#** National Oceanic and Atmospheric Administration, Miami, Fla. Research Facilities Center.

**DESCRIPTION AND OPERATING PROCEDURES FOR THE NOAA (NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION) C-130 AWRD (AIRBORNE WEATHER RECONNAISSANCE SYSTEM) SYSTEM**

K. J. HAYDU and E. R. DARBY Mar. 1983 61 p

(PB83-197053; NOAA-TM-ERL-RFC-11; NOAA-83042204) Avail: NTIS HC A04/MF A01 CSCI 04B

The AWRD located on board the C-130 is described. The AWRD was built to provide a better RECCO (Reconnaissance Code) system. The AWRD is a computer system which collects, assembles and displays flight and meteorological parameters to assist in the preparation of RECCOs. Chapter illustrations of the SWRS at the flight director's station and all of the control panels that the user should be familiar with in order to run the system are included. The minimum operational procedures that need to be performed. A detailed list of operational procedures which should be performed when time permits. Instruction for loading tapes and also deals with problems that may occur during this process. The Aircraft Satellite Data Link. GRA

## MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

**A83-47657\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**OPTICAL DATA PROCESSING FOR AEROSPACE APPLICATIONS**

R. L. STERMER (NASA, Langley Research Center, Hampton, VA) and M. SOKOLOSKI (NASA, Office of Aeronautics and Space Technology, Washington, DC) (International Optical Computing Conference, 10th, Cambridge, MA, Apr. 6-8, 1983) Optical Engineering (ISSN 0091-3286), vol. 22, Sept.-Oct. 1983, p. 146, 148, 150-153. refs

Optical data processing has a significant potential in future aerospace systems. In this paper, potential system applications are identified. One of the more important applications is the determination of errors of large antennas or reflector surfaces and the active control or compensation of the surface. Technological challenges to the application of optical data processing technology to aerospace systems are identified, and current NASA research efforts are discussed. Author

**A83-48336#**

**AIRCRAFT SYNTHESIS USING NUMERICAL OPTIMIZATION METHODOLOGY**

R. J. DE FILIPPO (Northrop Corp., Aircraft Div., Hawthorne, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 9 p. refs

(AIAA PAPER 83-2458)

The incorporation of numerical optimization techniques into aircraft synthesis methods provides a tool that can rapidly assess a multivariable aircraft design problem, directing the analysis to a practical solution. The aircraft synthesis program ACSYNT, which combines optimization and aircraft performance and sizing codes, has been integrated into Northrop's Advanced Configuration Analysis and Design (ACAD) system, providing an automated synthesis approach to the design process. The program affords the capability to optimize the size of vehicle required to fly a particular mission, while satisfying specific performance and physical design constraints. The synthesis process of conceptual design provides an aircraft sized to perform a desired mission prior to the first design drawing. A geometric representation of the synthesized aircraft is produced that is compatible with the three-dimensional Northrop Computer Aided Design (NCAD) system. The engineer can refine the configuration on NCAD, creating a common data base from which all the engineering disciplines can draw information to perform analyses to further develop the design. Author

**A83-48337#**

**CONCEPTUAL KINEMATIC DESIGN USING HOMOGENEOUS COORDINATE TRANSFORMATIONS**

D. P. RAYMER, R. A. MAIER, and M. J. KILLIAN (Rockwell International Corp., Los Angeles, CA) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 10 p. (AIAA PAPER 83-2460)

It is pointed out that computer-aided design (CAD) has produced a major revolution in the design of aircraft. The use of CAD is providing shorter design times, more iteration cycles, and ultimately, a better product. Essentially two-dimensional detail design layout can now be considered mature. However, three-dimensional computer-aided aircraft design is not as mature. Attention is given to a review of homogeneous coordinate transformations, the

inverse problem, the inverse solution, the applications of the inverse procedure, and the trunnion axis location. The presented methodologies expand greatly the capabilities of a CAD system employing local axis systems defined by X, Y, Z, roll, pitch, and yaw values using the homogeneous coordinate transformations.

G.R.

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### PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

**A83-47628**

#### NONSTATIONARITY IN ACOUSTIC FIELDS

Y. H. TSAO and J. K. HAMMOND (Southampton, University, Southampton, England) Acoustical Society of America, Journal (ISSN 0001-4966), vol. 74, Sept. 1983, p. 827-839. refs

Acoustic pressure fields measured by an observer when the source or observer or both are moving is a nonstationary random process even if the source generates a random process which is stationary in the reference frame of the source. The causes of nonstationarity are classified as being due to wave expansion, directivity, and Doppler shift. This paper is concerned with developing two-dimensional (frequency-time) spectral descriptions for the processes by constraining the processes to fit within the framework of the 'evolutionary spectral density'. Earlier literature has described how evolutionary spectra may be estimated from single sample realizations. Spectral representation forms for free-field acoustic processes produced by moving monopole and dipole excitations are derived from the fundamental wave equations.

Author

**A83-48191#**

#### SUBSONIC AND TRANSONIC PROPELLER NOISE [BRUIT DES HELICES SUBSONIQUES ET TRANSONIQUES]

S. LEWY and H. GOUNET (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (International Commission on Acoustics and International Union of Pure and Applied Physics, Congress International d'Acoustique, 11th, Paris, France, July 19-27, 1983) ONERA, TP, no. 1983-76, 1983, 5 p. In French. refs (ONERA, TP NO. 1983-76)

Models for the noise levels from propellers are discussed, with results compared to in-flight measurements. Methods originally applied to noise from light aircraft are modified and extended to high speed passenger aircraft. Noise emitted from propellers has three components: a monopolar emission due to the air displaced by a blade; a bipolar form from average and fluctuating forces exerted by the blades; and a quadrupolar component produced by deformation of the streamlines around the blade profile and defined by the Lighthill tensor. The latter is not a factor in the subsonic regime and can be neglected. Attention is given to a formalism which accounts for the sound level along each band, the frequency harmonics at each blade passage, the number of blades, and the rotation rate. The measured directivities of the two components are described. It is found that the radiated noise levels can be reduced in slow aircraft by lowering the peripheral velocity while keeping the same power with more blades. Calculations including the quadrupolar term are necessary for modeling noise levels in transonic propellers.

M.S.K.

**A83-48194#**

#### EXPERIMENTAL METHODS IN COMPRESSOR NOISE STUDIES

S. LEWY (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) and B. JUBELIN (SNECMA, Moissy Cramayel, Seine-et-Marne, France) ONERA, TP, no. 1983-79, 1983, 37 p. refs

(ONERA, TP NO. 1983-79)

Rotating blade machines are a very important source of aeronautical noise. The present investigation is concerned with studies of noise generated by axial compressors, taking into account aircraft jet engines. The introduction of high bypass ratio engines for subsonic transportation led to a very pronounced improvement in performance and, in addition, also to a significant decrease in jet noise. The fan has now become the primary noise source. The theoretical background of compressor noise studies is examined, taking into account the resolution of the wave equation in a guided medium, the cut-off properties of a duct, azimuthal modes generated by a rotating source, and consequences of the theoretical model. The sound emission upstream of a compressor at subsonic and transonic speeds is considered along with details regarding the experimental methods suited to the study of compressor noise.

G.R.

**A83-48195#**

#### HELICOPTER NOISE

S. LEWY and M. CAPLOT (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) ONERA, TP, no. 1983-80, 1983, 44 p. refs

(ONERA, TP NO. 1983-80)

The present status of knowledge of civil helicopter noise is presented. Turbohaft engine noise is addressed and theoretical and experimental studies on rotor tone noise are discussed. Broadband noise of helicopter rotors is considered. Finally, physiological acoustic problems caused by the impulsive character of the main rotor acoustic emission are examined. An appendix presents time domain and frequency domain formulations of the helicopter noise problem.

C.D.

**A83-49462**

#### NOISE GENERATION BY A LOW-MACH-NUMBER JET

J. LAUFER and T.-C. YEN (Southern California, University, Los Angeles, CA) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 134, Sept. 1983, p. 1-31. USAF-NSF-supported research. refs

Using a 'clean' jet facility the relationship between the jet flow and its radiation field was studied experimentally in the Mach-number range 0.05 to 0.20 and a Reynolds-number range 60,000 to 230,000. The various acoustic source parameters such as strength, frequency and Mach number were varied systematically, and the far-field pressure measured simultaneously. On the basis of these measurements the nature of the sources in the initial shear layer could be characterized. The principal results, equally valid for unexcited and excited jets, are as follows: the acoustic sources are not convected but are located within a confined volume fixed with respect to the nozzle even though they are being generated by moving disturbances in the jet; they are associated with the nonlinear saturation of the unstable wave amplitudes of the shear layer occurring at the vortex-pairing locations; the radiation intensity varies nonlinearly with the source strength and is highly directional, exponential in character.

Author

**A83-49463**

#### NOISE GENERATED BY AIRFOIL PROFILES PLACED IN A UNIFORM LAMINAR FLOW

H. ARBEY and J. BATAILLE (Lyon, Ecole Centrale, Ecully, Rhone, France) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 134, Sept. 1983, p. 33-47. refs

The paper is devoted to the experimental study of the noise generated by an airfoil profile placed in a uniform laminar flow. The far-field acoustic spectrum is shown to be composed of a broadband contribution around frequency  $f_s$  and a discrete contribution at equidistant frequencies  $f_n$ , which follow power laws

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of the forms  $f_s = U \exp 1.5$  and  $f_n = U \exp 0.85$ . Both contributions can be accounted for by a simple model derived from the original suggestions of Tam (1974) and Fink (1975). It is essentially assumed that the diffraction of the Tollmein-Schlichting instabilities by the trailing edge generates acoustic waves which propagate in the far field and also trigger an aeroacoustic feedback loop, whose length is equal to the distance between the trailing edge and the maximum velocity point of the airfoil. Author

**N83-36849#** Federal Aviation Administration, Washington, D.C. Office of Environment and Energy.

### **HELICOPTER NOISE SURVEY AT SELECTED NEW YORK CITY HELIPORTS**

E. J. RICKLEY, M. J. BRIEN, and S. R. ALBERSHEIM Mar. 1983 78 p Prepared in cooperation with Transportation Systems Center, Cambridge, Mass. (AD-A129167; FAA-EE-83-2) Avail: NTIS HC A05/MF A01 CSCL 20A

The FAA conducted a noise measurement survey of helicopter operations at three principal heliports in the borough of Manhattan in New York City on November 16-17, 1982. The purpose was to gather needed information for defining noise problems with in-service helicopter operations within urban areas. These noise data will be used to further define the environmental problems associated with helicopter operations in urban areas. Statistical community noise level data, measured over an 8-hour period at each selected site, are provided which reflect the noise levels at these sites from all local sources during that particular day. Noise data from individual helicopter operations are also provided. These data from helicopter targets of opportunity are termed survey data as opposed to controlled test data in order to reflect the limited control over factors which contribute to the variability of the measured noise level. Noise data are presented for the Augusta A-109, Bell 47J, Bell 206L, Bell 222, Boelkow B-105, and Sikorsky S-76. Author (GRA)

**N83-36851#** Pennsylvania State Univ., University Park. Lab. for Applied Research.

### **ROTOR NOISE DUE TO BLADE-TURBULENCE INTERACTION Ph.D. Thesis**

K. ISHIMARU 25 Jan. 1983 107 p refs (Contract N00024-79-C-6043) (AD-A129757; ARL/PSU/TM-83-27) Avail: NTIS HC A06/MF A01 CSCL 20A

The time-averaged intensity density function of the acoustic radiation from rotating blades is derived by replacing blades with rotating dipoles. This derivation is done under the following turbulent inflow conditions: turbulent ingestion with no inlet strut wakes, inflow turbulence elongation and contraction with no inlet strut wakes, and inlet strut wakes. Dimensional analysis reveals two non-dimensional parameters which play important roles in generating the blade-passing frequency tone and its multiples. The elongation and contraction of inflow turbulence has a strong effect on the generation of the blade-passing frequency tone and its multiples. Increasing the number of rotor blades widens the peak at the blade-passing frequency and its multiples. Increasing the rotational speed widens the peak under the condition that the non-dimensional parameter involving the rotational speed is fixed. The number of struts and blades should be chosen so that (the least common multiple of them)-(rotational speed) is in the cutoff range of Sears' function, in order to minimize the effect of the mean flow deficit on the time averaged intensity density function. GRA

**N83-36852#** Air Force Occupational and Environmental Health Lab., Brooks AFB, Tex.

### **THE C-9A INTERIOR NOISE EVALUATION Final Report, 28 Apr. - 2 May 1982**

C. M. JONES Feb. 1983 25 p refs (AD-A129256; OEHL-83-101EH174BNA) Avail: NTIS HC A02/MF A01 CSCL 20A

The USAF OEHL was requested by HQ MAC/SGPE to evaluate interior noise levels on the C-9A Nightingale aircraft during

aeromedical evacuation operations because of subjective opinion that the cabin has become more noisy in recent years. Measurements were made on 18 regular working flights of the 57th Aeromedical Evacuation Squadron (AES), Scott AFB IL. Noise exposure data indicated hazardous noise levels in the rear of the cabin only. Crew-member noise exposures could be effectively limited by the use of hearing protection. Author (GRA)

**N83-36988#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

### **JOURNAL OF ENGINEERING THERMOPHYSICS (SELECTED ARTICLES)**

13 May 1983 70 p refs Transl. into ENGLISH from Gongcheng Rewuli Xuebao (China), v. 2, no. 3, 1981 p 224-261 (AD-A129455; FTD-ID(RS)T-0416-83) Avail: NTIS HC A04/MF A01 CSCL 20M

Topics covered include: (1) characteristics and instability behavior of an axial compressor in a turbojet engine; (2) prediction of onset of rotating stall using small perturbation theory for axial flow compressors; (3) the principal equation for the aerodynamic calculation of the nonradial calculation station on S2 stream-surface flow in turbomachines; (4) numerical calculation of subsonic compressible turbulent flow in a conical diffuser; (5) the analysis of forces and powers in turbomachinery gas dynamics; (6) flow-field line relaxation solution for S2 relative stream surface with the splitter boundary condition; (7) the effect of casing treatment on performance of an axial compressor and (8) a calculation method for the rocket engine's optimum thrust nozzle contour design. GRA

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## SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

**A83-48334#**

### **LIFE CYCLE COST MANAGEMENT - AN ENGINEER'S VIEW**

J. L. PETTIGREW (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 10 p. refs (AIAA PAPER 83-2451)

Questions concerning the commitment to improving affordability are discussed, taking into account the use of basic tools of statistical analysis, an approach established by the Air Force Systems Command for developing and stabilizing the scope of all programs, and affordability as the real key to justifying a weapons system. Attention is also given to the economic future with the effect of compounding inflation, the cost of a tactical aircraft compared to inflation, the entropy of affordability, the entropy of specialization, the life cycle cost (LCC), the cost of improving affordability, aspects of feedback in system engineering, engineering for supportability, and questions regarding the accountability for the future today. G.R.

**A83-48340#**

### **AERONAUTICS - A COOP AEROSPACE EDUCATION PROGRAM AT UNIVERSITY OF SHERBROOKE, CANADA**

R. BOUDREAULT (Sherbrooke, Universite, Sherbrooke, Quebec, Canada) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 5 p. (AIAA PAPER 83-2474)

A83-49582#

**METHODS FOR TEACHING AEROSPACE VEHICLE DESIGN**

S. J. HOFFMAN (Illinois, University, Urbana, IL) American Institute of Aeronautics and Astronautics, Aircraft Design, Systems and Technology Meeting, Fort Worth, TX, Oct. 17-19, 1983. 27 p. (AIAA PAPER 83-2475)

An introductory course to aerospace vehicle design at the U. of Illinois is described, noting that the course matter requires the students to apply previously learned skills. Design teams are formed and each student is assigned a specific task which must be completed and integrated into the final team design. Written and oral reports are presented, together with weekly memos, to develop communications skills. Use is made only of proven techniques appropriate to conceptual design study. Specific projects to date have included a design for an orbit transfer vehicle, spacecraft communications and power subsystems, an asteroid rendezvous vehicle, and a comet rendezvous vehicle. Among the textbooks employed are Scientific Satellites by William Corliss and AIAA Case Study in Design: Landsat D. All the projects were developed around existing spacecraft, with an emphasis on trade-off studies.

M.S.K.

of a spin rig-qualified ceramic-bladed rotor assembly at 1132 C (2070 F) test conditions. Concurrently, ceramics from new sources and alternate materials continued to be evaluated, and fabrication of 2070 F-configuration ceramic component from these new sources continued. Cold spin testing of the critical 2070 F-configuration blade continued in the spin test rig to qualify a set of ceramic blades at 117% engine speed for the gasifier turbine rotor. Rig testing of the ceramic-bladed gasifier turbine rotor assembly at 108% engine speed was also performed, which resulted in the failure of one blade. The new three-piece hot seal with the nickel oxide/calcium fluoride wearface composition was qualified in the regenerator rig and introduced to engine operation with marginal success.

N.W.

N83-35943\*# Kentron International, Inc., Hampton, Va.

**PAN AIR GEOMETRY MANAGEMENT SYSTEM (PAGMS): A DATA-BASE MANAGEMENT SYSTEM FOR PAN AIR GEOMETRY DATA**

J. F. HALL Nov. 1981 33 p refs

(Contract NAS1-16000)

(NASA-CR-16581; NAS 1.26:165811) Avail: NTIS HC A03/MF A01 CSCL 05B

A data-base management system called PAGMS was developed to facilitate the data transfer in applications computer programs that create, modify, plot or otherwise manipulate PAN AIR type geometry data in preparation for input to the PAN AIR system of computer programs. PAGMS is composed of a series of FORTRAN callable subroutines which can be accessed directly from applications programs. Currently only a NOS version of PAGMS has been developed.

Author

N83-37015# Armament Systems, Inc., Anaheim, Calif.

**PROPOSAL AND JUSTIFICATION FOR THE ESTABLISHMENT OF AN AERONAUTICAL SYSTEMS-TARGET NONNUCLEAR SURVIVABILITY-VULNERABILITY INFORMATION ANALYSIS CENTER-SURVIAC Final Report**

R. BERNIER, D. MOWRER, and R. HORTON Oct. 1982 153 p

(Contract N00123-80-D-0033)

(AD-A130414; JTCG/AS-82-SM-006) Avail: NTIS HC A08/MF A01 CSCL 05B

This publication documents the results of a questionnaire/study to determine the need and justification for the establishment of a Department of Defense Information Analysis Center to collect, analyze, and disseminate scientific and technical information related to the survivability and vulnerability of aeronautical systems and other targets to nonnuclear threats. The report resulted in gaining approval for the SURVIAC.

GRA

N83-37028\*# General Motors Corp., Indianapolis, Ind.

**CERAMIC APPLICATIONS IN TURBINE ENGINES Progress Report, 1 Jul. - 31 Dec. 1980**

J. A. BYRD, M. A. JANOVCZ, and S. R. THRASHER Sep. 1981 165 p

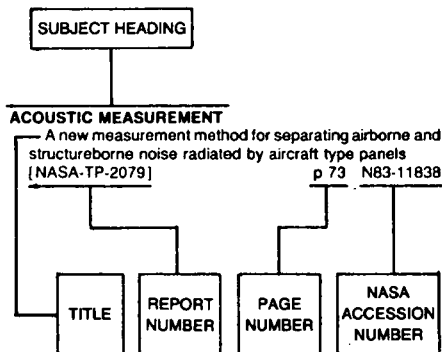
(Contract DEN3-17)

(NASA-CR-165494; DOE/NASA/0017-3; NAS 1.26:165494;

DDA-EDR-10672) Avail: NTIS HC A08/MF A01 CSCL 21E

Development testing activities on the 1900 F-configuration ceramic parts were completed, 2070 F-configuration ceramic component rig and engine testing was initiated, and the conceptual design for the 2265 F-configuration engine was identified. Fabrication of the 2070 F-configuration ceramic parts continued, along with burner rig development testing of the 2070 F-configuration metal combustor in preparation for 1132 C (2070 F) qualification test conditions. Shakedown testing of the hot engine simulator (HES) rig was also completed in preparation for testing

## Typical Subject Index Listing



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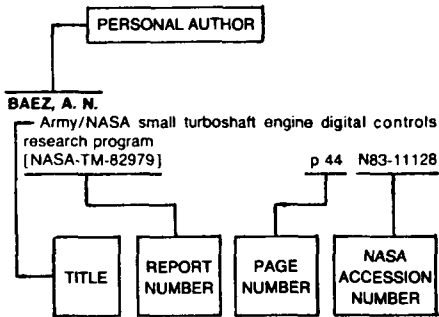
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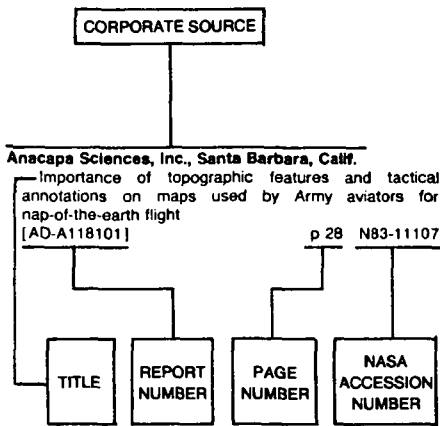
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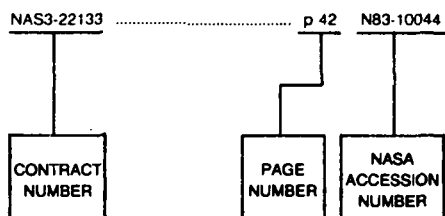
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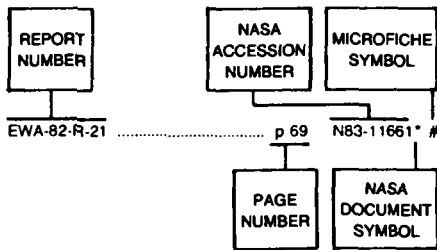
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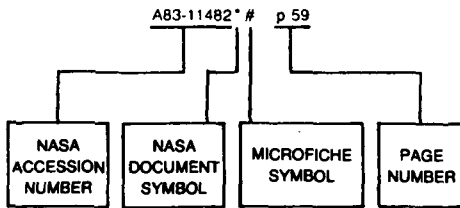
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